

THE AMPHIPOD SUPERFAMILY EUSIROIDEA IN THE NORTH AMERICAN PACIFIC REGION.
II. FAMILY CALLIPIOIDAE. SYSTEMATICS AND DISTRIBUTIONAL ECOLOGY.

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Abstract

The essentially bipolar eusiroidean family Calliopiidae is extensively revised, based mainly on material obtained in the eastern North Pacific coastal region since 1955. In this study, northern hemisphere genera of Calliopiidae, and species within the genera *Calliopius* and *Paracalliopiella* are keyed and illustrated.

Broadly within the genus *Calliopius* the following subunits are recognized: (1) a boreal North Pacific subgroup of *C. carinatus*, n. sp., *C. pacificus*, n. sp., and *C. columbianus*, n. sp.; (2) a primitive subarctic North Pacific species, *C. behringi* Gurjanova; and (3) a relatively advanced subarctic-boreal North Atlantic subgroup comprising *C. laeviusculus* (Kr.), *C. crenulatus* Chevreux & Fage, *C. rathkii* (Zaddach) and *C. sablensis*, n. sp. The North Pacific endemic genus *Paracalliopiella* comprises: (1) a primitive subgroup of large carinated species containing *P. bungei* (Gurjanova), *P. shoemakeri*, n. sp., and *P. haliragoides*, n. sp.; (2) a further primitive subgroup of smaller and less strongly carinated species, including *P. beringiensis*, n. sp. and *P. tzvetkova*, n. sp.; (3) a more advanced subgroup of *P. pacifica* Tzvetkova & Kudrjaschov, *P. slatteryi*, n. sp., and a more distantly related *P. kudrj-aschovi*, n. sp.; and (4) a most advanced subgroup of *P. litoralis* (Gurjanova) and *P. pratti* (J. L. Barnard).

Other North Pacific calliopiid taxa treated here include *Oligochinus lighti* Barnard, endemic to North American coastal marine shallows; *Bouvierella carcinophila* (Chevreux) and *Oradarea longimana* (Boeck) from deep fiords of British Columbia; and the genus *Laothoes* (*L. polylovi* Gurjanova, and *L. pacifica* Gurjanova) of subarctic Asiatic Pacific waters. Peripheral to the Bering Sea region are *Halirages fulvocincta* M. Sars and *H. nilssoni* Ohlin, *Apherusa glacialis* (Hansen) and *A. megalops* (Buchholz); and *Weyprechtia pinguis* (Kroyer), and *W. heugleni* (Buchholz).

In the northern hemisphere, the family Calliopiidae is centred in the High Arctic region from whence it has apparently radiated into the North Pacific (15 spp. in 7 genera), North Atlantic (20 spp. in 7 genera), and the deep sea (3 spp. in 3 genera). Bipolar subgroups include the relatively primitive and morphologically "plastic" genera *Halirages*, *Haliragoides*, and *Oradarea*; fourteen other genera are exclusively antarctic and anti-boreal. Along the subarctic and boreal North American Pacific coast the family Calliopiidae is moderately diverse, with 10 species in 6 genera, whereas only 5 species in 3 genera have been recorded from equivalent waters of the western North Pacific region. None lives wholly within warm-temperate marine regions.

Calliopiids, along with pontogeneiids and perhaps bateids, are relatively unspecialized, mainly littoral and epibenthic, marine eusiroidean carnivores and detritivores. Morphologically advanced members within the genera *Calliopius*, *Paracalliopiella*, and *Apherusa* exhibit some degree of sexual dimorphism of the gnathopods. Such functional morphology within taxa of selected inshore habitats may reflect an increasingly benthic life style in which pre-amplexing reproductive behaviour is presumed to be advantageous.

INTRODUCTION

The family Calliopiidae was first proposed by G. O. Sars (1895) to encompass a group of medium- to small-bodied, coastal marine eusiroideans having a natatory uropod 3 and entire telson. Initially the group consisted of eight northern hemisphere genera: *Calliopius* Liljeborg, 1865, *Laothoes* Boeck, 1871, *Amphithopsis* Boeck, 1861, *Halirages* Boeck, 1871, *Leptamphopus* G. O. Sars, 1895, *Cleippides* Boeck, 1871, *Apherusa* Walker, 1891, and *Haliragoides* Sars, 1895, and five southern hemisphere genera, *Stenopleura* Stebbing, 1888, *Harpinioides* Stebbing, 1888, *Chosroes* Stebbing, 1888, *Atylopsis* Stebbing, 1888, and *Schraderia* Pfeffer, 1888. In a subsequent expansion and redefinition of the group, Stebbing (1906) added the genera *Sancho* Stebbing, 1897, *Paraleptamphopus* Stebbing, 1899, and *Paracalliopie* Stebbing, 1899, all from the region of Australia and New Zealand (ANZAC). J.L. Barnard (1958) included six addi-

tional genera from the southern hemisphere and the deep sea, viz., *Bouvierella* Chevreux, 1900, *Calliopiella* Schellenberg, 1925, *Clarencia* K.H. Barnard, 1931, *Metaleptamphopus* Chevreux, 1911, *Regalia* K.H. Barnard, 1930, and *Stenopleuroides* Birstein and Vinogradov, 1964, and one from the Northern Hemisphere, *Oradarea* Walker, 1903, for a combined total of 20 genera. More recent additions include *Oligochinus* Barnard, 1969b, *Rozinante* Stebbing, 1897, and *Paracalliopiella* Tzvetkova & Kudrjaschov, 1975 (= *Callaska* J.L. Barnard, 1978), with *Leptamphopus litoralis* Gurjanova as the type species.

It is not the purpose of this paper to revise the family Calliopiidae in its entirety. However, an important new dimension to its understanding has been added by the present diverse new material from the North Pacific region. Further revision of the group must be based on detailed comparison with members of the type genus *Calliopius* as here re-

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examined and redefined. If we employ as prime character states the type and occurrence of antennal calceoli, the form of the mouthparts (esp. the mandibular palp and maxilliped), and the presence of pleated coxal gills, setose uropod 3, unmodified peraeopod 7, and unkeeled entire telson, at least three subgroupings (subfamilies) within the family can be recognized, as outlined below. Particularly significant would be the transfer of *Atylopsis* to the Pleustidae (see Bousfield & Hendrycks, 1994), and *Paraleptamphopus* (along with *Falklandella* and related groups from continental fresh waters of the Southern Hemisphere) to separate family groupings (Bousfield & Shih, 1994; Bousfield, in prep).

Studies of North Pacific regional calliopiids have been infrequent. A few early records are included in Stebbing (1906). Holmes (1904) listed no calliopiids from the Alaskan coast, and his calliopiids from off the coast of California (1908) later proved to be species of Eusiridae (see Bousfield & Hendrycks, 1995). Neither Stout (1913), nor Alderman (1936) worked up their extensive collections of Calliopiidae. The calliopiid records of Barnard (1954, 1958, 1969a, b) are summarized in the generalized keys and accounts of Barnard (1975), Armstrong *et al.* (1976), Staude *et al.* (1977), Staude (1987), and Barnard & Karaman (1991). Studies on species of the Bering Sea region have been summarized mainly by Gurjanova (1951), and Tzvetkova & Kudrjaschov (1975). A very few records of calliopiids from northern Japan (e.g., in Nagata, 1965) have been summarized by Ishimaru (1994).

ACKNOWLEDGEMENTS

Several institutions and interested colleagues contributed to the success of this study. Most material was obtained during the course of regional field expeditions of the National Museum of Natural Sciences (NMNS), now Canadian Museum of Nature (CMN), led by the senior author, during the period 1955 - 1980. Valuable assistance in the field was provided by the Pacific Biological Station, Nanaimo, and the Bamfield Marine Station. Detailed acknowledgements are provided in the published station lists of Bousfield (1958, 1963, 1968), Bousfield & McAllister (1962), and Bousfield & Jarrett (1981). Charles O'Clair (1977) and Peter Slattery (pers. comm.) obtained material from the Bering Sea and Aleutian regions, kindly made available for this study. For the loan of additional study material, the authors are indebted to the Royal British Columbia Museum, Victoria, B. C., the Zoological Institute, St. Petersburg, Russia, and the Smithsonian Institution, Washington, D. C.

Taxonomic research was conducted mainly at the NMNS (now CMN) in Ottawa, and the use of its collections and facilities is gratefully acknowledged. Valuable commentary on the text was provided by Dr. Craig P. Staude, Friday Harbor Laboratories (FHL), WA, Marjorie Bousfield, Wolfe Island, Ont., and Patrick Shaw, Canadian Wildlife Service (CWS), Vancouver, B. C. The illustrations were prepared with the very capable assistance of Susan Laurie-Bourque, Hull, Quebec. Marjorie Bousfield also provided translations of pertinent Russian literature.

The authors gratefully acknowledge research support from the Natural Sciences and Engineering Research Council of Canada, and from the Royal Ontario Museum, Toronto.

SYSTEMATICS

Family Calliopiidae G. O. Sars, 1895 (revised status)

Calliopiidae G. O. Sars, 1895: 431.—Stebbing 1906: 285 (part).—Gurjanova, 1951: 599.—Barnard, 1969a: 167 (part).—Bousfield, 1973: 79.—Lincoln, 1979: 404 (part).—Bousfield, 1982a: 265.

Eusiridae Stebbing, 1888: 953 (part).—Barnard & Karaman, 1991: 284 + key (part).

Type genus: *Calliopi*us Liljeborg, 1865 (TYPE - *Amphithoe laeviusculus* Kroyer, 1838).

Northern Hemisphere genera: *Amphithopsis* Boeck, 1861 (TYPE - *A. longicaudata* Boeck, 1861); *Apherusa* Walker, 1891 (TYPE - *Amphithoe jurinei* Milne-Edwards, 1830); *Bouvierella* Chevreux, 1900 (TYPE - *B. carcinophila* (Chevreux, 1889)); *Cleippides* Boeck, 1871 (TYPE - *Acanthonotus tricuspis* Kroyer, 1846); *Dolobrotus* Bowman, 1974 (= *Schraderia* Pfeffer, 1888?) (TYPE - *D. mardeni* Bowman, 1974); *Halirages* Boeck, 1871 (TYPE - *Amphithoe fulvocincta* M. Sars, 1858); *Haliragoides* G. O. Sars, 1895 (TYPE - *Halirages inermis* G. O. Sars); *Laothoes* Boeck, 1871 (TYPE - *Laothoes meinerti* Boeck, 1871); *Leptamphopus* G. O. Sars, 1895 (TYPE - *Leptamphopus sarsi* Vanhoffen, 1897); *Oligochinus* J. L. Barnard, 1969b (TYPE - *Oligochinus lighti* Barnard, 1969b); *Oradarea* Walker, 1903 (TYPE - *O. walkeri* Shoemaker, 1930); *Paracalliopiella* Tzvetkova & Kudrjaschov, 1975 (TYPE - *Leptamphopus litoralis* Gurjanova, 1938); *Rozinante* Stebbing, 1894 [TYPE - *R. fragilis* (Goes)]; *Weyprechtia* Stuxberg, 1880 (TYPE - *W. heugleni* Buchholz, 1874).

Diagnosis. Body often dorsally carinated on pleon, occasionally on peraeon. Rostrum short to medium. Eyes large, well pigmented. Head lobe truncated or narrowly incised; inferior antennal sinus sharply incised. Antennae (of males often, and females occasionally) calceolate; peduncular segments short. Antenna 1 usually shorter than antenna 2; accessory flagellum small, often minute, occasionally lacking; callynophore usually lacking, rarely weakly developed.

Mouthparts basic. Upper lip simple, apex rounded or slightly incised. Lower lip, inner lobes lacking or weakly developed. Mandible normally developed; molar strong, triturative, with distal flagellum; palp segment 3 normal or shorter than 2. Maxilla 1 regular, inner plate setose; outer plate with 9-11 apical spines; palp 2-segmented, occasionally reduced. Maxilla 2, inner plate, facial row of setae variously reduced. Maxilliped normal, strong; outer plate often large or modified.

Coxal plates 1-4 medium, increasing posteriorly, lacking hind cusp. Gnathopods subsimilar, subchelate, trending to

sexual dimorphism (propod more powerful in male); carpus (especially of gnathopod 2) variable, often elongate.

Peraeopods 3 & 4 regular, dactyls short to medium. Peraeopods 5-7 regular, homopodous; coxae posterolobate; postero-distal angles of segments 4 & 5 weakly produced.

Pleon segments large, uncoalesced. Pleopods strongly developed, especially in male. Pleon plates regular, hind corners variable. Urosome segments separate. Uropods 1 & 2, rami sublanceolate or sublinear, outer ramus the shorter, margins serially spinose, apices unequally spinose. Uropod 3, rami lanceolate, subequal, margins serially spinose, plesiomorphically setose.

Telson plate-like, apex acute, rounded, or variously notched; penicillate setae in two pairs, inner member of distal pair often spine-like.

Coxal gills usually strongly pleated, especially in male. Brood plates very broad and strongly marginally setose; occasionally slender, weakly setose on peraeopod 5.

Males usually slightly smaller than females, and having more slender body form, more strongly calceolate antennae, larger eyes, and stronger gnathopods.

Taxonomic Commentary. The family Calliopiidae encompasses a number of morphologically diverse generic forms that share many symplesiomorphies but few synapomorphies. Based on type of calceolus, the family Calliopiidae is closely related to family Pontogeneiidae in the more primitive subgroup of families of superfamily Eusiroidea (Stapleton *et al.*, 1988, Bousfield & Shih, 1994; Bousfield & Hendrycks, 1995). Perhaps paradoxically, eusiroideans have developed the most complex (and presumably most advanced) forms of calceoli (Lincoln & Hurley, 1981; Barnard, 1989), and surface ultrastructure (Halcrow & Bousfield, 1986), yet exhibit many of the most plesiomorphic macromorphological character states within the entire assemblage of gammaridean amphipods (Bousfield, 1982a, 1983). Such a combination of macroplesiomorphies, combined with the dominance of component families along ancient (e.g., ANZAC and North Pacific) coastlines, suggests a relatively early lineage for superfamily Eusiroidea, extrapolated for mid-Mesozoic (Bousfield, 1982b).

The present authors have not followed Barnard & Karaman (1991) in submerging Calliopiidae, Pontogeneiidae and Gammarellidae within family Eusiridae (*sens. lat.*). Recognized families within superfamily Eusiroidea are treated in Bousfield & Hendrycks (1995). Doubtless the morphological overlap between families, homoplasious or otherwise, is real, and is complemented by the somewhat similar life styles (free-swimming detritivores (Enequist, 1949) and carnivores) and overlapping distributional ecologies of selected member species. On these bases, a reasonable case can be made for merging families Pontogeneiidae and Calliopiidae (p. 61). On the other hand, the imperfectly known antarctic genus *Clarencia* K. H. Barnard, 1931, was given separate family status (Clarenciidae) by Barnard & Karaman (1987). The genus *Calliopiurus* (type species *C. excellens* Bushueva, 1986) from intermediate depths in the

antarctic Davis Sea region, is superficially calliopiid in its short rostrum, linear subsimilar gnathopods, and short, plate-like telson. However, in its combination of other character states including a relatively deep, narrow, eyeless head, callynophorate antenna 1, highly modified mouthparts, narrow coxal plates, heteropodous bases of peraeopod 5-7, slender lanceolate uropods, and notched telson apex, the species encompasses features of several other mainly non-calliopiid and even non-eusiroidean families. Its classificatory status is here considered uncertain. With few exceptions, members of family Eusiridae possess a distinct accessory flagellum, specialized calceoli (when present), often well developed callynophore, specialized mouthparts (mandible with large incisor, reduced molar, slender palp), powerfully raptorial gnathopods, elongate peraeopods, serrate pleon plate 3, and large, narrowly separated telson lobes (Bousfield & Hendrycks, 1995).

Compared to eusirids, members of family Calliopiidae tend to be more detritivorous in feeding style, and occupy inshore, shallow-water and benthic habitats (Enequist, 1949). Their adaptive morphology is reflected in a mixture of plesiomorphic and apomorphic character states such as simple calceoli, loss of accessory flagellum, relatively "basic" mouthparts (toothed incisor, large molar), relatively unspecialized gnathopods, short stoutly dactylate peraeopods, simple pleon plates, linear uropod rami, and plate-like telson. Some coxal gills remain pleated in *Calliopiurus*. As treated by Barnard (1958) and Barnard & Barnard (1983), most calliopiids are marine, and most are (or tend to be) powerful swimmers, even if primarily benthic crawlers and scavengers (e.g., *Bouvierella*, *Oradarea*, *Dolobrotus*). Their reproductive style is primarily synchronously free-swarming in the water column (Conlan, 1991; Bousfield & Shih, 1994). However, inshore benthic calliopiids, especially in more southerly ranging species of genera such as *Apherusa* and *Paracalliopiella*, demonstrate a tendency towards both dissimilarity and sexual dimorphism of the gnathopods.

It is not surprising, therefore, that attempts have been made to split up this somewhat unwieldy calliopiid assemblage into more naturally related (phyletic) units. The freshwater paraeptamphopids of New Zealand and Tasmania have been placed in a separate family group, allied to the Falklandellidae of the South Atlantic continental island (Bousfield, 1980, Bousfield & Shih, 1994). Some antipodean marine genera (*Atylopsis*, *Harpinioides*) have been given subfamily status within the Pleustidae (Bousfield & Hendrycks, 1994). The genera *Gammarellus* and *Weyprechtia* were transferred from Gammaridae and given separate family status (Gammarellidae) within Eusiroidea by Bousfield (1977, 1979), but were subsequently submerged within Calliopiidae (Bousfield, 1983). Barnard (1989) recently resurrected family Gammarellidae to encompass *Gammarellus*, *Austroregia* and *Chosroes*, on the basis of synapomorphies in the microstructure of antennal calceoli. Single-character diagnoses of higher taxonomic groups are inherently risky and unstable, even when based on such fundamentally significant characters as antennal calceoli.

KEY TO NORTHERN HEMISPHERE GENERA OF CALLIOPHIDAE

1. Accessory flagellum prominent, 2+ segmented (Fig. 36); mandibular palp segment 3 distinctly longer than segment 2 (Fig. 38) *Weyprechtia* (Stuxberg) (p. 54)
 —Accessory flagellum minute, 1-segmented or lacking (Fig. 15, 20); mandibular palp segment 3 equal to or shorter than segment 2 (Fig. 25). 2.
2. Antennae calceolate (Figs. 2, 13); antenna 1, peduncular segment 3 with postero-distal process; uropod 3, rami subequal, margins setose (Fig. 11) 3.
 —Antennae lacking calceoli; antenna 1, peduncular segment 3 unmodified; uropod 3, rami various, margins spinose or with spines and weak inner marginal setae only (Figs. 21, 34). 4.
3. Gnathopods 1 & 2 sexually dimorphic (Fig. 22); telson entire, linguiform (Fig. 1); pleon plate 3, hind margin smooth (Fig. 1). *Calliopius* Lilj. (p. 7)
 —Gnathopods similar in both sexes; telson apically notched (Fig. 30); pleon plate 3, hind margin toothed (Fig. 30) *Halirages* Boeck (p. 45)
4. Gnathopod 2, carpus and propod very slender, elongate, much longer than gnathopod 1 (Fig. 34) . . . 5.
 —Gnathopod 2 little longer than gnathopod 1, carpus and propod short or not elongate (Figs. 1, 33). . . 8.
5. Pigmented eyes lacking; telson distinctly cleft (Fig. 35) *Bouvierella* Chevreux (p. 51)
 —Pigmented eyes present; telson shallowly notched or entire (Fig. 34). 6.
6. Uropod 3, rami subequal in length; peraeopods 3-7, dactyls spinose *Cleippides* Boeck
 —Uropod 3, rami markedly unequal; peraeopod dactyls smooth, normal 7.
7. Accessory flagellum 1-segmented; gnathopod 2, propod elongate, longer than basis. . *Oradarea* (p. 49)
 —Accessory flagellum lacking; gnathopod 2, propod shorter than basis *Leptamphopus* G. O. Sars
8. Antenna 1, aesthetascs conspicuous, on alternating flagellar segments (Figs. 17, 18) 9.
 —Antenna 1, aesthetascs inconspicuous and/or present on all flagellar segments (Figs. 11, 30). 13.
9. Peraeopods 3-7, dactyls serrated; mandibular palp segment 3 broadened *Amphithopsis* Boeck
 —Peraeopod dactyls normal, smooth; mandibular palp segment 3 not broadened medially 10.
10. Telson apically cleft; gnathopods 1 & 2 sexually similar 11.
 —Telson entire, apex rounded or acute; gnathopods sexually dimorphic 12.
11. Inferior antennal head lobe acutely produced; accessory flagellum lacking *Rozinante* (Goes)
 —Inferior antennal head lobe not produced; (Fig. 15); accessory flagellum 1-segmented
 *Oligochinus* J. L. Barnard (p. 24)
12. Accessory flagellum lacking; mainly North Atlantic, Arctic *Apherusa* Walker (p. 47)
 —Accessory flagellum 1-segmented; North Pacific endemic . . . *Paracalliopiella* Tzvet. & Kudrj. (p. 26)
13. Maxilliped, outer plate abnormally enlarged (Fig. 31); maxilla 2, inner plate lacking facial setae; pleon plate 3, hind margin smooth *Laothoes* Boeck (p. 47)
 —Maxilliped, outer plate normal; maxilla 2, inner plate with facial setae; pleon plate 3, hind margin with one tooth *Haliragoides* G. O. Sars.

Thus, presumptions must be made about otherwise closely related groups in which all members lacking calceoli. However, the taxonomic level and phyletic ordering of the nine categories of calceoli described by Lincoln and Hurley (1981) have been reorganized on a more consistent phyletic basis (Bousfield & Shih, 1994). Thus, the simple body and serial elements of the phoxocephalid and crangonyctid types

of calceoli (nos. 8 & 9 of Lincoln & Hurley, *loc. cit.*) appear to be more rationally placed at the plesiomorphic, rather than apomorphic, end of the phyletic scale. Moreover, some convergence of form is apparent in separate lineages; the advanced oedicerotid form, presumably from a paracalliopiid ancestral type, is similar to the complex eusirid type presumably derived from a pontogeneiid ancestral form.

Despite these reservations, however, we are inclined to support Barnard's revival of family Gammarellidae, with the expectation that other antipodean genera will fall into this family concept following more comprehensive analyses of surface microstructure. *Weyprechtia*, however, is tentatively retained within the Calliopiidae, since its calceolus is primitively pontogeneiid in form (viz., Bousfield & Shih, 1994, Fig. 9). Further subdivision of family Calliopiidae may be helpful, perhaps employing subfamily categorizations after the fashion of Barnard and Drummond (1978) or Bousfield & Hendrycks (1994), but is beyond the scope of the present regional study*.

Calliopus Liljeborg

Calliopus Liljeborg, 1865: 11.—Stebbing, 1906: 295.—Gurjanova, 1951: 617.—Barnard, 1969a: 176.—Bousfield, 1973: 80.—Lincoln, 1979: 480.—Barnard & Karaman, 1991: 313.

Type species. *Calliope Leachii* Bate 1857 (= *Amphithoe laeviuscula* Krøyer, 1838).

North Pacific Species: *Calliopus behringi* Gurjanova, 1951; *C. carinatus*, new species (p. 13); *Calliopus pacificus*, new species (p. 16); *Calliopus columbianus*, new species (p. 19).

North Atlantic Species. *Calliopus rathkii* (Zaddach, 1844); *C. crenulatus* Chevreux & Fage, 1925; *C. sablensis*, new species (p. 13) (+ *C. laeviusculus*).

Diagnosis. Body medium, robust, weakly to strongly mid-dorsally carinated or tuberculated, especially on the pleon; cuticle often highly pigmented in mottled or banded patterns. Head, rostrum short but distinct; inferior head lobe not produced. Eyes large, subrectangular, strongly pigmented. Antennae stout, not elongate; antenna 1 shorter than 2; distal peduncular and flagellar segments calceolate (both sexes); calceoli simple (pontogeneiid type). Antenna 1, peduncular segment 3 with variously developed posterodistal process; accessory flagellum minute, variously fused with segment 3; flagellum faintly (or not) basally callynophorate.

Mouthparts regular. Lower lip with weak inner lobes. Mandible, palp segment 3 large, falciform, with 1-3 basofacial groups of "A" setae; segments 1 & 2 with inner marginal setae; left lacinia 5-7 dentate, right lacinia 3-4 cusped; spine row medium strong. Maxilla 1 normal; right palp broadly 2-segmented; inner plate with 2-6 apical setae; outer plate with 11 apical spines. Maxilla 2, inner plate narrowed, with 1-2 facial seta, one often strong. Maxilliped plates regular, not enlarged; palp strong.

* Stapleton et al. (1988) count 18 families of amphipods in which one or more known species bear calceolate antennae. However, the actual number is closer to 30 families, in 8 superfamily (or equivalent) groups, as outlined by Bousfield & Shih (1994, p. 94).

Coxae 1-4 medium deep. Gnathopods 1 & 2 powerfully subchelate, raptorial, subsimilar, slightly sexually dimorphic; propod palms oblique, with 3-5 spines near posterodistal angle; dactyls minutely setulose behind; carpus short, deep; merus small.

Peraeopods 3-4 regular; segment 5 not shortened; dactyls stout, curved. Peraeopods 5-7 homopodous, increasing posteriorly; bases broadly rounding, hind lobes distinct.

Pleon plates 2-3 broad, hind margins smooth, lower margins (and often facially) spinose; hind corners acuminate, not produced. Pleopods strong, slightly sexually dimorphic. Uropods 1 & 2, rami sublinear, apices truncate, spinose, outer ramus shorter. Uropod 3, rami subequal, margins variously setose and short-spinose, inner ramus broadly lanceolate.

Telson linguiform, apex rounded; penicillate setae median. Coxal gills on peraeopods 3 & 4 strongly pleated, especially in male. Brood plates large, margins strongly setose.

Taxonomic and distributional commentary. Members of the genus *Calliopus* are markedly distinct from other northern genera of calliopiids. *Calliopus* appears most closely allied with other phylogenetically advanced genera, namely *Apherusa*, *Paracalliopiella* and the South African genus *Calliopiella* (Table I, and Fig. 39). Apomorphic character states include stout antennae with posterodistal peduncular process and vestigial accessory flagellum; powerfully developed, slightly sexually dimorphic gnathopods with short deep carpal segments; well developed peraeopod dactyls; sublinear, apically spinose uropods 1 & 2, and plate-like telson. However, *Calliopus* retains several plesiomorphies including strongly calceolate antennae, relatively unmodified mouthparts, fully homopodous peraeopods, and strongly setose and natatory uropod 3 (both sexes).

Distributionally the genus *Calliopus* is subarctic-boreal, and ecologically eulittoral along high salinity rocky coasts of the North Atlantic and North Pacific regions. Members are generally associated with winter conditions of icing or low temperature (5-10°C.), but are absent from both high arctic and warm temperate shores. Their plesiomorphic calceolate antennae and natatory uropod 3, in combination with apomorphically powerfully raptorial and sexually dimorphic gnathopods, well developed peraeopod dactyls, and linear uropod rami presumably facilitate their primarily free-swimming and perching/clinging life style, near shore, along mainly rocky coasts.

Calliopus laeviusculus (Krøyer) (Fig. 1)

Amphithoe laeviusculus Krøyer, 1838: 281.

Calliopus laeviusculus (Kr.) Sars, 1895: 449, pl. 158.—Stebbing, 1906: 296.—Gurjanova, 1951: 618, fig. 419.—Barnard, 1969a: 176, fig. 71a.—Bousfield, 1973: 80, pl. XIV.1.—Lincoln, 1979: 406, fig. 193.

non Calliopus laeviusculus (Kr.) Wailes, 1931: 40.—Wailes, 1933: 8.—Barnard, 1954: 8, pl. 8.—Bousfield, 1970: 34.

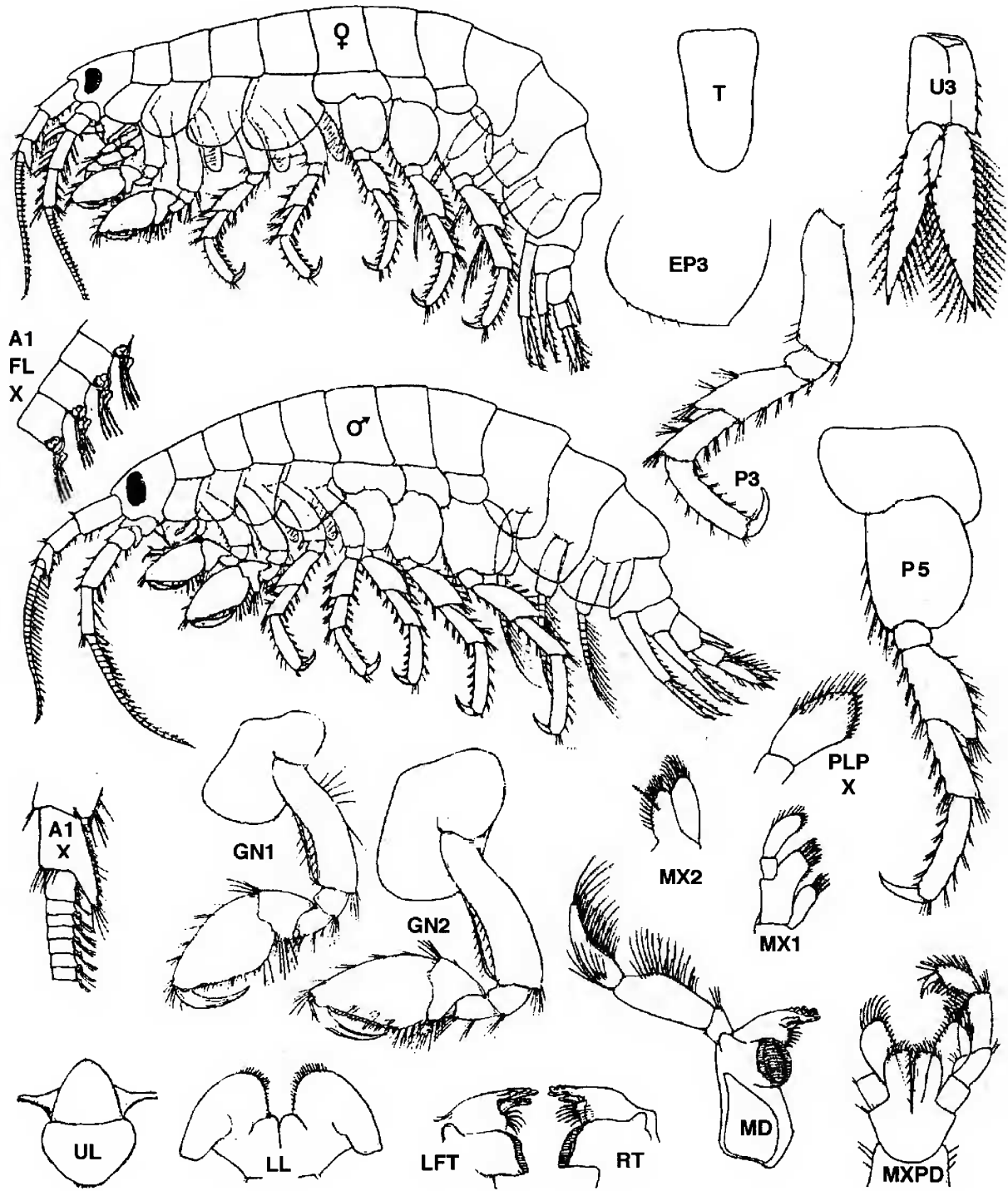


Fig. 1. *Calliopius laeviusculus* (Kroyer). Northeastern Atlantic region. Fem. (12.0 mm); male (13.0 mm). (after Sars, 1895)

Material Examined: None authentically from study region. Previous records from the North Pacific (e.g., Wailes, Barnard, *loc. cit.*) are possibly attributable to one or more of the regional new species described below. Comparative North Atlantic material (CMN, Ottawa) was utilized here.

Diagnosis. Body nearly smooth, with low carinations mid-dorsally on pleonal, rarely on posterior 1-2 pereaeonal,

segments. Head, eyes intermediate, broadly reniform. Inferior head margin vertical. Antenna 1 & 2, calceoli relatively large, in single posterior (inner) marginal rows; peduncular segment 3 short, posterodistal process intermediate, little exceeding 1st flagellar segment; accessory flagellum barely discernible, apex with several setae.

Mandibular palp segment 3 large, apex acute, subequal in length to segment 2; basal "A" setae strong (7-11 in main

KEY TO SPECIES OF *CALLIOPIUS*

- 1. Antennal calceoli in three to several rows on posterior face of peduncular segments; Pacific species . . . 2.
—Antennal calceoli in 1(2) rows along posterior margin of peduncular segments; Atlantic species 5.
- 2. Antenna 1, posterodistal process of peduncular segment 3 extending along 4-6 basal flagellar segments; uropod 2, outer ramus short (length ~1/2 inner ramus); gnathopods 1 & 2 little larger in male than in female *C. behringi* Gurjanova (p. 21).
—Antenna 1, posterodistal peduncular process short, not extending beyond flagellar segment 1; uropod 2, outer ramus ~2/3 length of inner ramus; gnathopods 1 and 2 distinctly sexually dimorphic 3.
- 3. Peraeon segments 5-7 and pleon segments 1 & 2 distinctly carinate; pleon plate 2, facial setae in 5-7 submarginal rows *C. carinatus*, n. sp. (p. 13)
—Peraeon and pleon segments not (or weakly) carinate; pleon plate 2, facial setae in 2-3 submarginal rows 4.
- 4. Antennal flagella short (<20 segments); peraeopods 5-7, dactyls large, heavy, ~1/3 length of segment 6; maxilla 1, inner plate with 2 apical setae *C. pacificus*, n. sp. (p. 16)
—Antennal flagella elongate (>30 segments); peraeopods 5-7, dactyls small, <1/3 length of segment 6; maxilla 1, inner plate with 5 apical setae *C. columbianus*, n. sp. (p. 19)
- 5. Uropod 3, rami conspicuously setose on inner and outer margins 6.
—Uropod 3, rami conspicuously setose on inner margin only 7.
- 6. Antenna 1, posterodistal process of peduncular segment 3 elongate, exceeding flagellar segment 1; pleon plate 2, facial spines in submarginal row *C. laeviusculus* (Kr.) (p. 17)
—Antenna 1, peduncular posterodistal process short, length <flagellar segment 1; pleon plate 2, facial spines in 3 submarginal rows *C. sablensis*, n. sp. (p. 13)
- 7. Coxae 1-4, lower margin distinctly crenulate; peraeopods 5-7, dactyls strong, length > 1/3 segment 6 *C. crenulatus* Chevreux & Fage (p. 11)
—Coxae 1-4, lower margin nearly smooth; peraeopods 5-7, dactyls short, slender, length <1/3 segment 6 *C. rathkii* (Zaddach) (p. 10)

cluster, left palp). Maxilla 1, inner plate with 4 setae. Maxilla 2, inner plate, facial seta strong. Maxilliped, outer plate intermediate.

Coxal plates 1-4 medium, deeper than broad, rounded below. Gnathopods 1 & 2, palmar margins with 4 medium stout spines near posterior angle. Anterior facial setae strong (up to 6 clusters).

Peraeopods 3 & 4 medium stout, segment 5 slightly shorter than 4. Peraeopods 5-7 closely homopodous, margins spinose only; segment 4 moderately broadened; dactyls medium. Basis of peraeopod 7 regularly rounded behind, posterodistal lobe not broadening distally; segment 6 not as long as basis, with 5-6 anterior margin spine clusters.

Pleon plates 2 & 3, facial spines few, in clusters of 2-3, middle spine slender, hind corner obtuse, very weakly acuminate. Uropod 2, length of outer ramus 2/3 inner ramus; apical spines medium. Uropod 3, inner ramus not strongly broadened; outer ramus, outer margin with 7-8 singly inserted spines and setae.

Telson elongate linguiform, basally broadest; apex evenly rounded.

Coxal gills narrowly sac-like, smallest on peraeopod 7.
Female: body slightly larger and more robust than male;

LEGEND FOR FIGURES

A1	- antenna 1	MX2	- maxilla 2
A2	- antenna 2	MXPD	- maxilliped
AC FL	- accessory flagellum	O. P.	- outer plate
BR PL	- brood plate	P3-7	- peraeopods 3-7
CLC	- calceolus	PED	- peduncle
CX	- coxa	PL	- pleopod
DCTL	- dactyl	PLEON	- pleon segments
EP	- epimeral plate	PLEOS	- pleosome
FL	- flagellum	PLP	- palp
GN1	- gnathopod 1	RT	- right
GN2	- gnathopod 2	SET	- seta
HD	- head	SP	- spine
I. P.	- inner plate	T	- telson
LAC	- lacinia	U1-3	- uropods 1-3
LFT	- left	UROS	- urosome
LL	- lower lip	X	- magnified
MD	- mandible	♂	- male
MX1	- maxilla 1	♀	- female

gnathopod propods smaller and less powerful. Brood plates large, broad, margins moderately fully setose

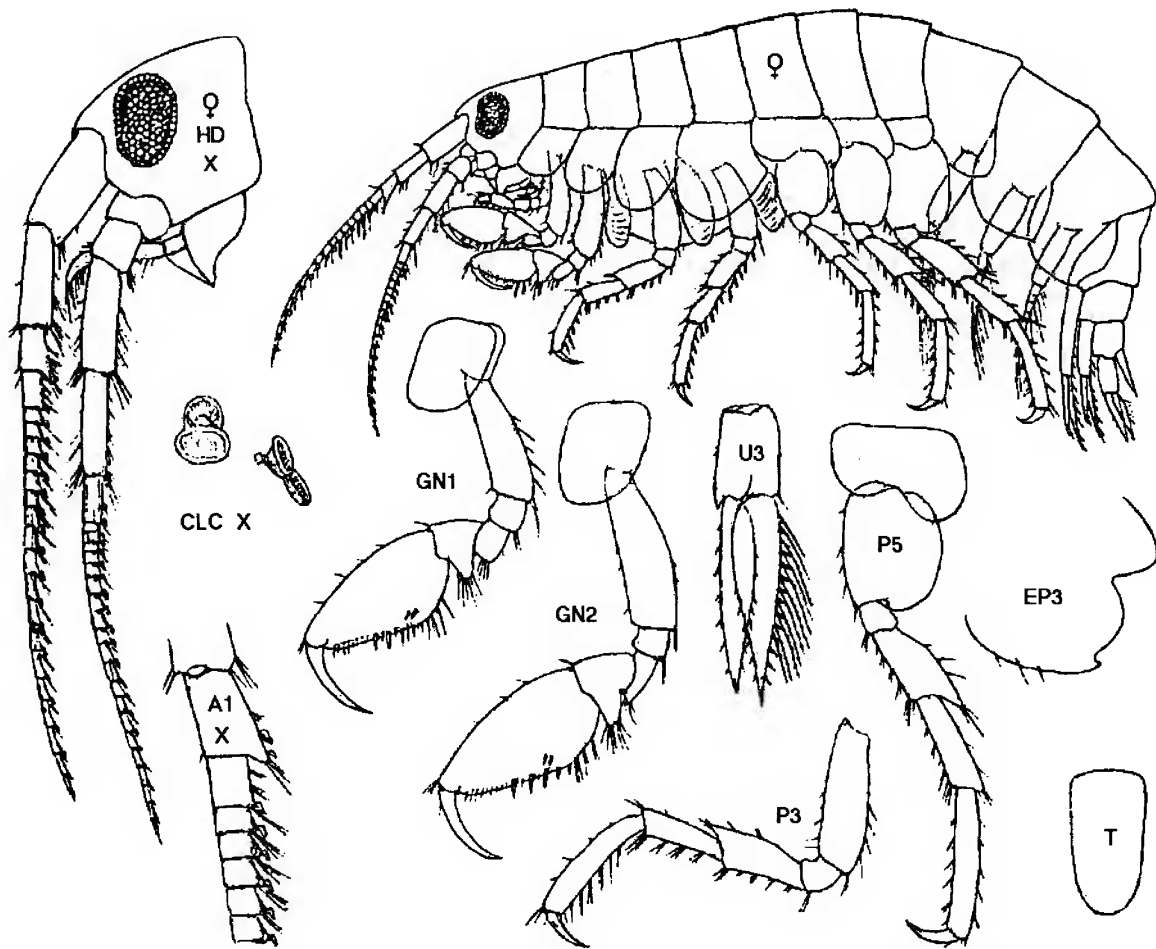


FIG. 2. *Calliopius rathkii* (Zaddach). North Sea. Female (7.0 mm) (after Sars, 1895).

Distribution. A subarctic and boreal North Atlantic species. Previous records from the North American Pacific region [e. g., Barnard (1954, 1971); Wailes (1933); Dagg, 1975] have not been verified.

Taxonomic commentary: *Calliopius laeviusculus* Kr., as the type species of the genus, is rediagnosed here on the basis of new taxonomic features. Some records from the North American Pacific region (e. g., Wailes, 1931, 1933) were based on identifications by the late C. R. Shoemaker. However, the material, possibly still in Smithsonian Institution collections, may contain other species.

Calliopius rathkii (Zaddach)
(Fig. 2)

Amphithoe rathkii Zaddach, 1844: 6.

Calliopius rathkii (Zaddach) Stebbing, 1906: 297.

Calliopius rathkei (Zaddach) G. O. Sars, 1895: 447, pl. 157.

Calliopius laeviusculus (Kr.) Schellenberg, 1942: 89.—Gurjanova, 1951: 618 (part).—Lincoln, 1979: 406 (part).—Barnard & Karaman, 1991: 313.

Material Examined. Nyborg fiord, Denmark (Copenhagen Museum) - male (8.1 mm); female (8.7 mm)..

Diagnosis. Female (8.7 mm): Body nearly smooth dorsally. Head, eyes very large, broadly reniform, black. Antennae 1 & 2 short. Antenna 1, flagellum with 17 regular segments; peduncular segment 3 with very short distal process; accessory flagellum very small, low conical; calceoli large, in single posterior row on peduncular segments 2 & 3, and on flagellum. Antenna 2, peduncular segment 5 shorter than 4; calceoli on peduncular segment 5 and proximal flagellar segments.

Mandible, right palp with 5 setae in main baso-facial "A" cluster, and single supernumerary seta. Other mouthparts not described.

Coxae 1-4 deeper than wide, strongly convex and smooth below. Gnathopods 1 & 2, propods relatively small, palmar margins very oblique, nearly straight, longer than corresponding posterior margins, with 3-4 spines near postero-distal angle; dactyls relatively short.

Peraeopods 3 & 4 slender; segment 5 not reduced; dactyls slender. Peraeopods 5-7 homopodous, bases not wider than deep, gently convex behind. Peraeopod 7, basis regular, lower lobe shallow; segment 4 not broadened; segment 6 longer than basis, anterior margin with 4-5 setal clusters.

Pleon plate 2 with a few facial and submarginal spines, mostly singly inserted; hind corner acuminate. Pleon 3, with 6 lower submarginal spines; hind corner acuminate. Uropod

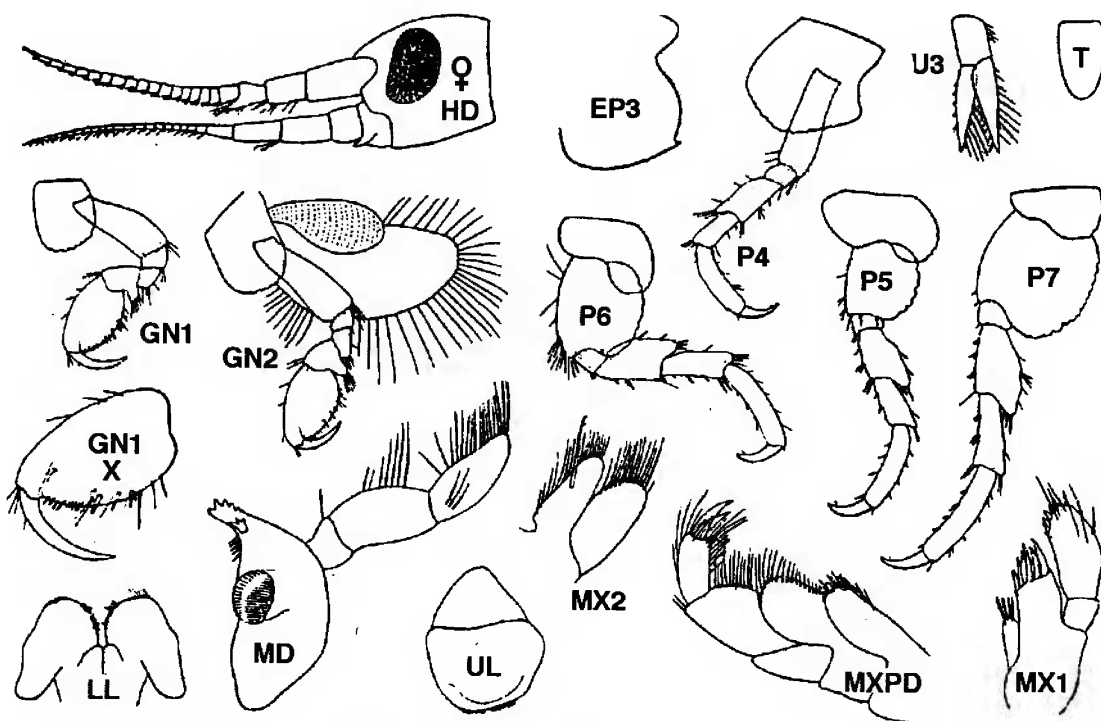


FIG. 3. *Calliopius crenulatus* Chevreux & Fage. Concarneau, France. Female (7.0 mm) (after Chevreux & Fage, 1925).

1, outer ramus distinctly the shorter. Uropod 2, outer ramus 2/3 length of inner, apical spine not elongate. Uropod 3, inner ramus broad, inner margin setose, outer margin spinose; outer ramus much more slender, margins spinose.

Telson of medium length, slightly less than twice width, slightly narrowing to evenly rounded apex.

Male (8.1 mm): Gnathopod propods more robust than in female. Uropod 3, outer ramus with inner marginal setae.

Distribution. From southern Norway and the British Isles to the Channel coast of France.

Taxonomic commentary. The species is here considered distinct from *C. laeviusculus*, with which it has been synonymized by several authors. *C. rathkii* differs mainly in the short antennal peduncular process, narrow coxae 1-4, and other characters of the key (p. 9)

Calliopius crenulatus Chevreux & Fage
(Fig. 3)

Calliopius crenulatus Chevreux & Fage, 1925: 183, figs. 189, 190.

Calliopius laeviusculus Lincoln, 1979: 406 (part).—Barnard & Karaman, 1991: 313.

Diagnosis. Female (to 7 mm): Body very weakly (or not) carinated on pleon. Head, eyes large, subreniform. Antennae 1 & 2 subequal in length; calceoli large, in single row along posterior margin of distal peduncular and flagellar segments. Antenna 1 peduncular process short; flagellum 19-

segmented; accessory flagellum undescribed. Antenna 2, flagellum 18-21-segmented.

Mandibular palp segment not strongly falciform, length ~segment 2. Maxilla 1, inner plate with 4 apical setae; right palp medium stout, with 8 apical conical spines. Maxilla 2, inner plate narrow, facial seta prominent. Maxilliped, outer plate expanded, broader than inner, apical margin with few (6-8?) curved setae.

Coxal plates 1-4 subquadrate, rounded and strongly crenulated below. Gnathopod propods short, deep; palmar margin longer than posterior margin, with 3-4 spines near posterodistal angle.

Peraeopods 3 & 4, segment 5 slightly shorter than 4. Peraeopods 5-7 stout; bases broadly rounded behind, posterior margin coarsely crenulate; segment 4 relatively broad; segment 6 not longer than basis; dactyls strong.

Pleon plates 2 & 3, facial spines weak or lacking, hind margin of 3 convex, hind corner distinctly mucronate. Uropod 2, rami not described. Uropod 3, inner ramus little broader than outer ramus; outer ramus lacking outer marginal setae.

Telson relatively short, length/width ratio ~ 1.6. Male: Not described.

Distribution. Known only from southwestern Norway to the Channel coast of France and the Brittany peninsula, but apparently not reaching the Mediterranean (Chevreux & Fage, 1925).

Taxonomic commentary. Lincoln (1979) considers *C. crenulatus* merely a small southern variant of *C. laeviusculus* and the present phenetic analysis (Fig. 40, p. 60) confirms a

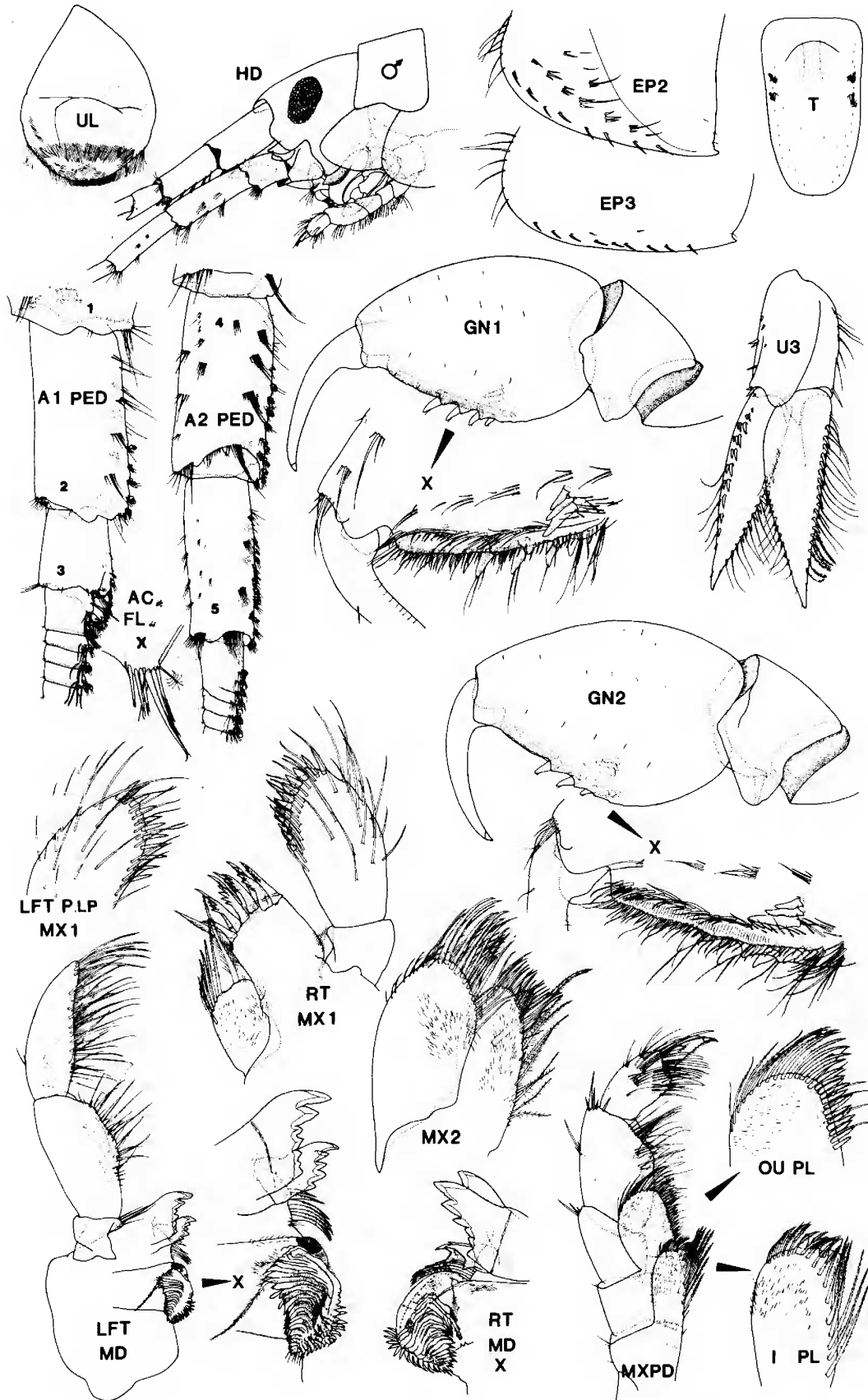


FIG. 4. *Calliopius sablensis*, new species. Salt lake, Sable I. Female (12.5 mm); male (13.0 mm).

close morphological similarity. However, *C. crenulatus* is clearly distinct from *laeviusculus* in characters of the key (p. 7). The strongly and more coarsely crenulated hind margin of the bases of pereopods 5-7 and the much smaller size at maturity are also diagnostic. *C. crenulatus* differs from *C. rathkii* in the latter's narrower coxae 1-4, more slender segment 4 of pereopods 5-7, spinose margins of the outer ramus of uropod 3, and more elongate telson.

Calliopius sablensis, new species
(Fig. 4)

Calliopius laeviusculus (Kr.) Bousfield, 1970: 36.—Bousfield, 1973: 80 (part).

Material Examined. Wallace Lake, Sable I., off Nova Scotia, Northwest Atlantic, dip net over sand, JEH Martin coll., July 15, 1967 - 1 male (13.0 mm) **Allotype**; 2 male **Paratypes** (12.5 mm); 1 female ov. (12.5 mm) **Holotype**, CMN collections, Ottawa.

Diagnosis. Female (12.5 mm). Pleon weakly mid-dorsally carinate. Head, inferior lobe, margin vertical, slightly sinuous. Eye medium, elongate subovate. Antennae 1 & 2 moderately elongate, flagella ~25-30-segmented, little or not setose; calceoli small, in single posterior marginal row on peduncular segments. Antenna 1, segment 3 short, peduncular process small, shorter than first flagellar segment; accessory flagellum very short, distal margin with 7-8 setae.

Mandible, palp segment 3 not strongly falcate, inner margin strongly setose; right palp, principal baso-facial cluster with 8 "A" setae, and 3 supernumerary setae; left lacinia irregularly 5-dentate; spine row with 6-7 blades. Maxilla 1, inner plate with 5 apical setae; right palp segment 2 broad, with 11-12 conical apical spines; left palp slender, oblique apical margin with 10 slender spines. Maxilla 2, inner plate with single slender facial seta and 4 proximal marginal setae. Maxilliped, outer plate relatively short, with 12 curved apical setae; inner plate relatively short, narrow.

Coxae 1-4 subquadrate, about as deep as wide, gently rounded below. Gnathopod propods relatively short, deep; palmar margins short, not longer than corresponding posterior margin, with 3-4 proximal spines.

Pereopods 3 & 4, segment 5 not shortened; segment 6, hind margin with 8-9 spine clusters; dactyls medium. Pereopods 5-7, bases very broad, hind margin convex, narrowing slightly distally to large lower lobe; segment 4 not strongly broadened; segment 6 with 8-9 anterior marginal spine clusters.

Pleon plate 2, facial setal groups in 3 marginal and submarginal rows. Pleon 3, lower margin with 9-10 short spines, hind corner minutely acuminate. Uropod 2 stout, length of outer ramus 2/3 inner ramus, with 5-6 serially paired marginal spinose; apical spines short. Uropod 3, inner ramus very broad basally, narrowing strongly; inner margin setose and spines; outer ramus with 8-9 short spines and 5-6 distal setae, apex broadly rounded.

Telson little narrowing distally, length barely twice width. Male (13.0 mm). Very similar to female. Gnathopods scarcely more robust; right palp segment 3, main cluster with 11 baso-facial setae.

Distributional ecology. Known only from the type locality, a brackish lake on Sable Island, off Nova Scotia.

Taxonomic commentary. *Calliopius sablensis* is clearly distinct from *C. laeviusculus* and other N. Atlantic species but exhibits plesiomorphic character states of the *C. carinatus* subgroup of the North Pacific region.

Calliopius carinatus, new species
(Figs. 5, 6, 7)

Calliopius laeviusculus Barnard, 1954: 8, plate 8.—Wailes, 1933: 8—Austin, 1985: 589 (part).—Barnard & Karaman, 1991: 313 (part)?

Calliopius carinatus Shaw MS, 1987.

Calliopius sp. Staude, 1987: 378 (part) (non fig. 18.76)?

Material Examined.

ALASKA:

Kenai Peninsula & Prince William Sound. ELB Stns, July, 1961: A136 (2); A130 (6) A121 (9); A140 (3); A153 (5). NE Gulf of Alaska. ELB Stns, June, 1961: A73 (Icy Bay) (10 spms., slide mount); A71 (~118 males, females, 2 slide mt.); A67 (Yakutat Bay) (2).

Southeastern Alaska. ELB Stns, 1961: A55 (Icy Strait) (50); A30 (2); A33 (20 spms., slide mt.); A7 (Ketchikan) (1 female + slide). ELB Stns, July-Aug., 1980: S11B3 (5); S10F1 (2); S16B1 (82 specimens, 2 slide mts.).

BRITISH COLUMBIA:

North-central mainland coast. ELB Stn, 1959 N16 (Johnstone Strait) (4). ELB Stns, July, 1964: H16 (Skeena R.) (6); H10 (106); H23 (1); H3 (15).

Vancouver Island, inner coast. ELB Stns, Aug., 1959: V7 (Alert Bay) (1); V11 (4); V20 (6); V22 (Oyster Bay - 10 specimens including **fig'd** male (10.5 mm). ELB Stn F8 (San Juan Is.), July, 1955 - 18 specimens + 2 slide mts., incl. **fig'd** male (11.7 mm.).

South end. ELB Stns, Aug., 1959: 017 (Wickaninnish Bay) (20 males, females, 2 slide mts.). ELB Stns, Aug., 1955: P4 (4); P8 (4). ELB Stn, July, 1978: B12b (2). ELB Stn., July, 1970: P707 (3). ELB Stns, July 1964: H44 (1); H41 (2).

Juan de Fuca Strait. ELB Stn F3 (Witty's Lagoon), Aug. 16, 1955.- 26 specimens incl. male **holotype**; female **allotype**. CMN collections.

WASHINGTON & OREGON:

Strait of Juan de Fuca. ELB Stns, July-Aug., 1966: W39 (Cape Flattery) (216 specimens, 2 slide mts.); W42 (7); W36 (Clallam Bay) (10); Puget Sound. ELB Stns, July, 1966: W30 (Fort Flagler Beach) (1 female); W9 (12); W11 (3).

Olympic Peninsula: W24 (2); W22 (Pt Grenville) (13).

Oregon, outer coast. ELB Stns, Aug., 1966: W53 (Neahkannie beach) - 8 spms., incl. male variant (**fig'd**); W66 (10 spms., slide mt.); W63 (10); W61 (Neskowin Beach) (1 female).

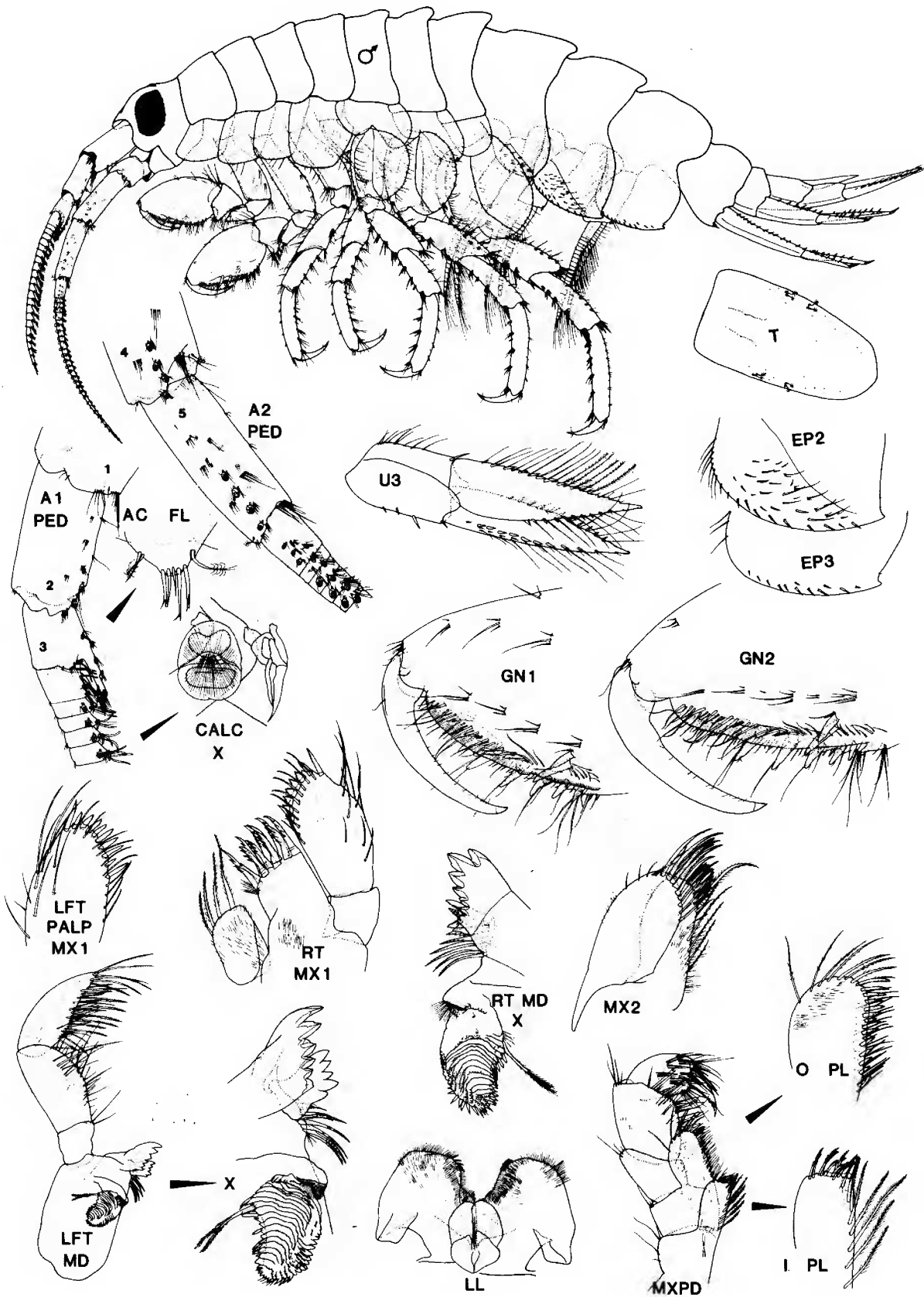


FIG. 5 *Calliopius carinatus*, new species. Witty's Lagoon, V. I., B. C. Male (9.5 mm); female (8.5 mm).

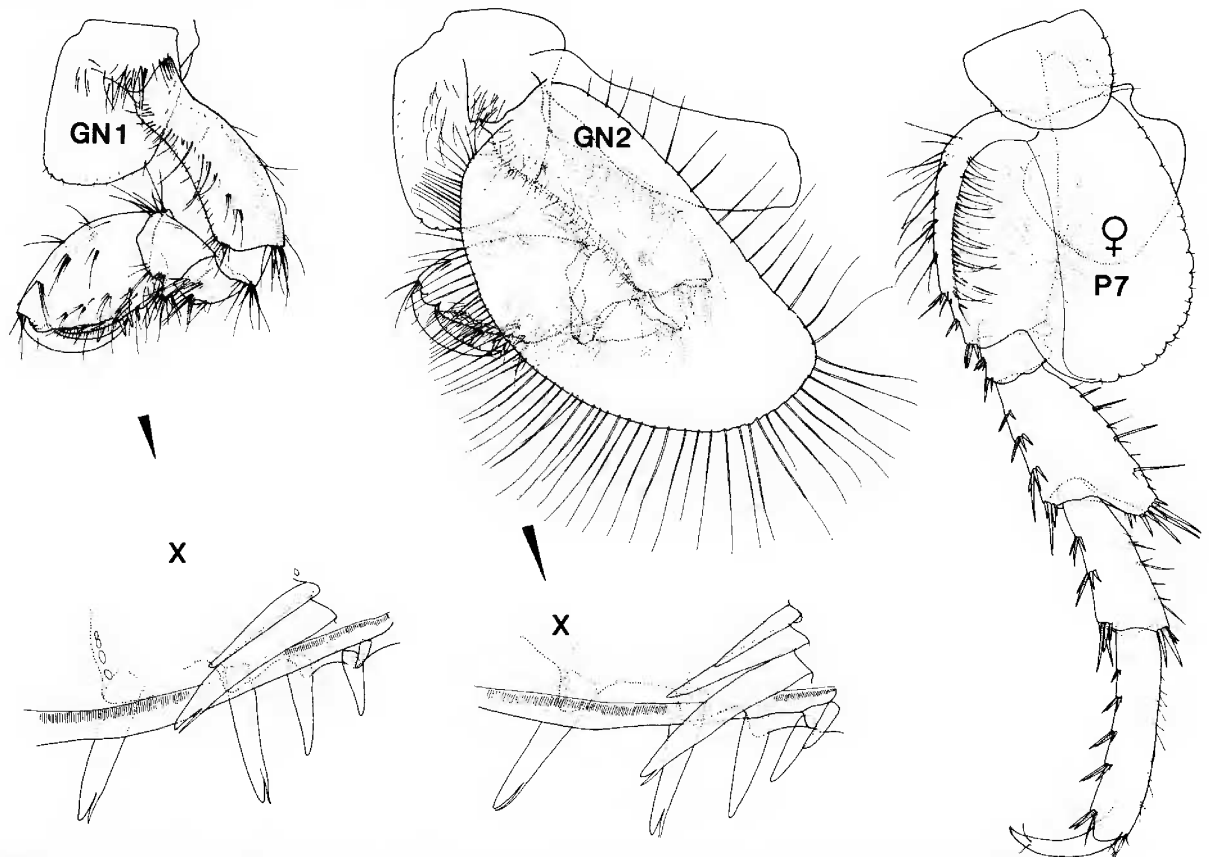


FIG. 6. *Calliopius carinatus* new species. Witty's Lagoon, V. I., B. C. Female (8.5 mm).

Diagnosis. Male (9.0 mm.): Body variously carinated or tuberculated on posterior peraeonal and pleonal segments. Head, eyes large, black, subrectangular. Antenna 1 $\frac{2}{3}$ length of antenna 2; flagellum with 22 segments; segment 3, peduncular process shorter than weakly callynophorate basal flagellar segment; accessory flagellum very short, triangular, apex with 4-6 short slender spines; calceoli small, in 2-3 posterior marginal and submarginal rows.

Lower lip, inner lobes distinct. Mandibular palp segments 2 & 3 subequal in length, 3 lacking basal cluster of "A" setae; spine row with 5 blades. Maxilla 1, inner plate with 4 apical setae; right palp moderately broad, apex oblique, with 8 conical spines; left palp with 7 slender apical spines. Maxilla 2, inner plate with single slender facial seta. Maxilliped, outer plate relatively short, apical margin with ~8 curved setae; inner plate short; palp strong, segment 2 stout.

Coxal plates 1-4 short, subquadrate, gently convex below. Gnathopods 1 & 2, propods large, palmar margin strongly oblique, submarginally setose, longer than posterior margin, with 4-5 stout spines near posterodistal angle; 3-4 weak clusters of distal median facial setae.

Peraeopods 3 & 4 relatively long; segment 5 not shortened; dactyls strong. Peraeopods 5-7 distinctly increasing in length; bases somewhat dissimilar, that of peraeopod 5 distinctly smallest. Peraeopod 7, basis broadening posterodistally, hind margin irregularly crenulated; segment 4 slightly broadened; segment 6 slightly longer than basis, with 4-5 anterior marginal clusters of spines.

Pleon plate 2 with numerous slender facial and marginal

spines, nearly all singly inserted. Pleon plate 3 with closely submarginal row of about 10 short spines, and a few supernumerary spines; hind corner acuminate. Uropod 1, rami unequal, much shorter than peduncle. Uropod 2, outer ramus ~ $\frac{2}{3}$ length of inner ramus; apical spine elongate. Uropod 3, inner ramus relatively slender, both margins setose; outer ramus, outer margin with 8-10 pairs of short spines and setae.

Telson elongate, length about twice width, slightly narrowing distally, apex regularly rounded, spade-shaped.

Coxal gills 2-6 elongate sac-like, that of peraeopod 7 large, irregularly plate-like.

Female (8.5-11 mm). Gnathopods 1 & 2 much smaller and less robust, and peraeopods 5-7 shorter than in male. Brood plates very large, broad, margins strongly setose.

Etymology. From the Latin root "carina" or keel, with reference to the carinated body dorsum.

Distributional ecology. Known from eastern Prince William Sound, Alaska, to the central coast of Oregon. Common in the surf swash zone, mainly along rocky shores, from fully marine to mesohaline inshore waters. Usually associated with submerged plants and algae.

Taxonomic commentary. Materials at hand exhibit considerable morphological variation throughout the range. Specimens from outer coast and northern localities tend to be more strongly carinate (Fig. 7A). The species is most closely similar to *C. pacificus* (see Fig. 40, p. 60).

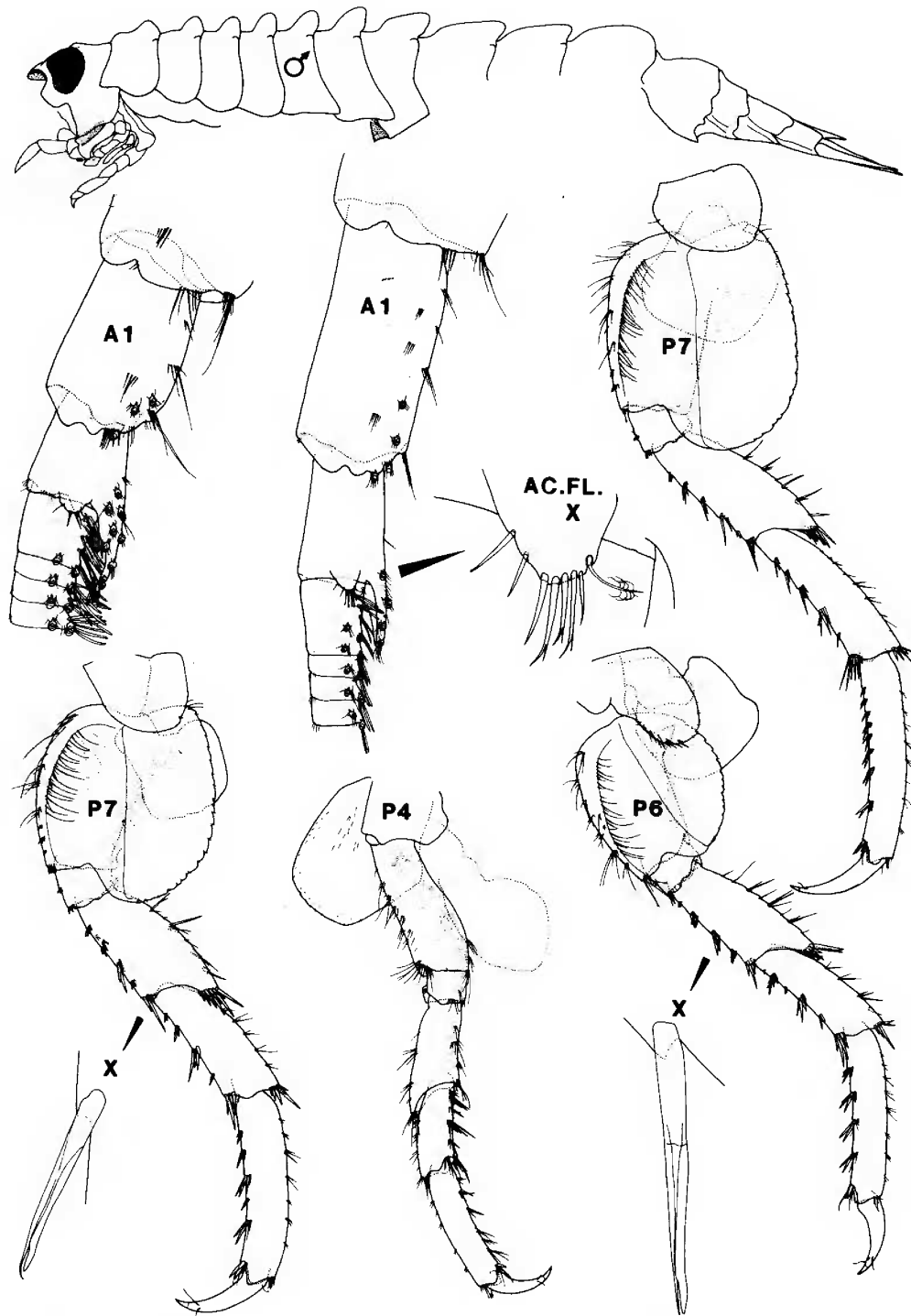


FIG. 7. *Calliopius carinatus*, new species. Morphological variations. A. Neahkannie Beach (W53), Oregon. Male (10.5 mm); B. Oyster Bay (V22), Georgia Strait, B. C. Male (10.5 mm); C. Friday Harbor (F8), WA. Male (11.7 mm).

Calliopius pacificus, new species
(Figs. 8, 9)

Calliopius laeviusculus (Kr.) Barnard, 1954: p. 8, pl. 8 (part)

Material Examined. 70 records - SE Alaska to Oregon.

CMN collections, Ottawa.
ALASKA.

Southeastern Alaska. Prince William Sound entrances. ELB Stns, July, 1961: A80 (10); A99 (10); A98 (11); A121(1). Southeastern Alaska. ELB Stns, July, 1980: S8B2 (N. Chichigof I.) (19 females); S5B1 (1 female); ELB Stns, June-

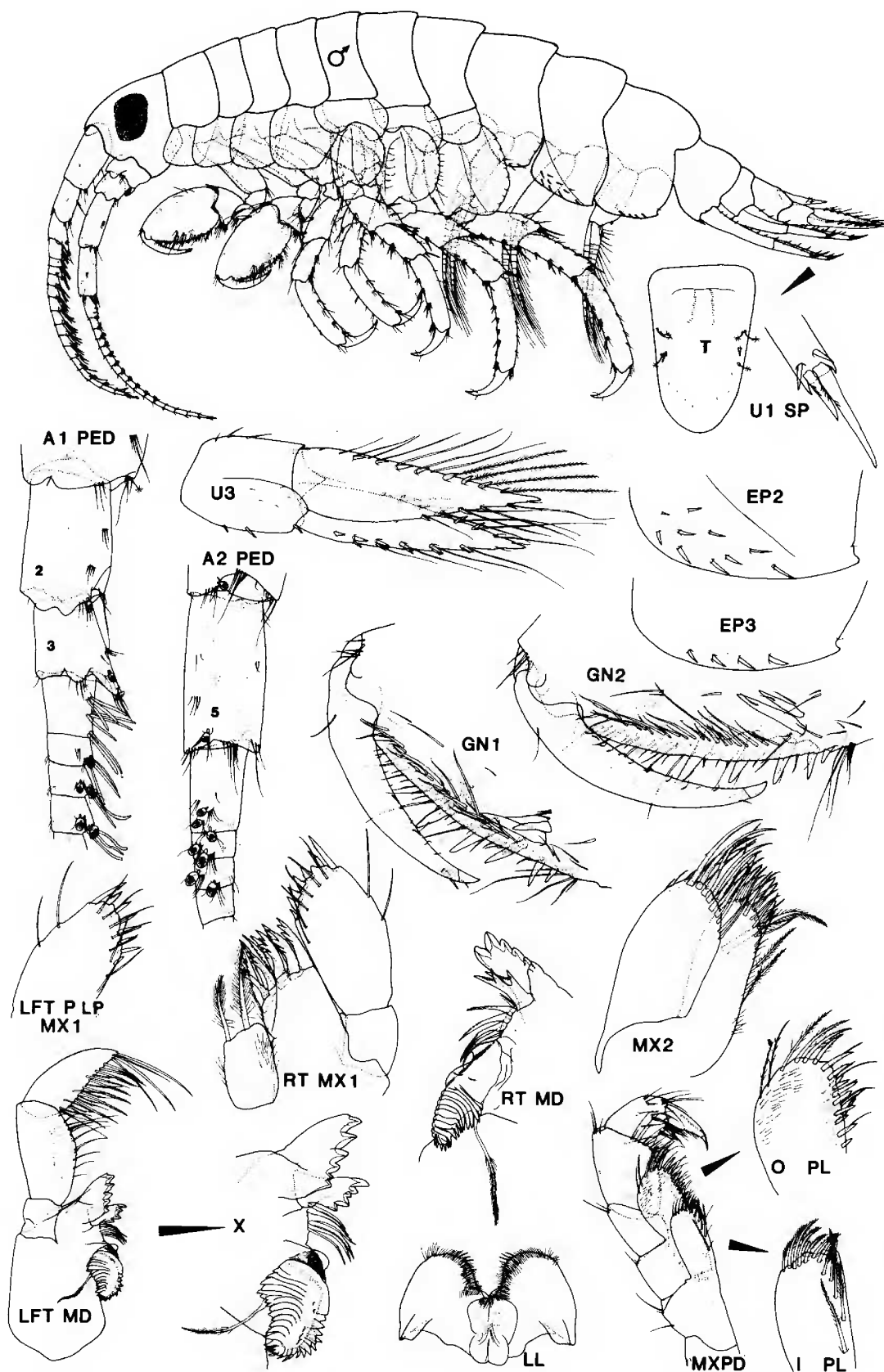


FIG. 8. *Calliopius pacificus*, new species. Off Selma Park (M5), Georgia Strait, B. C. Male (14.3 mm).

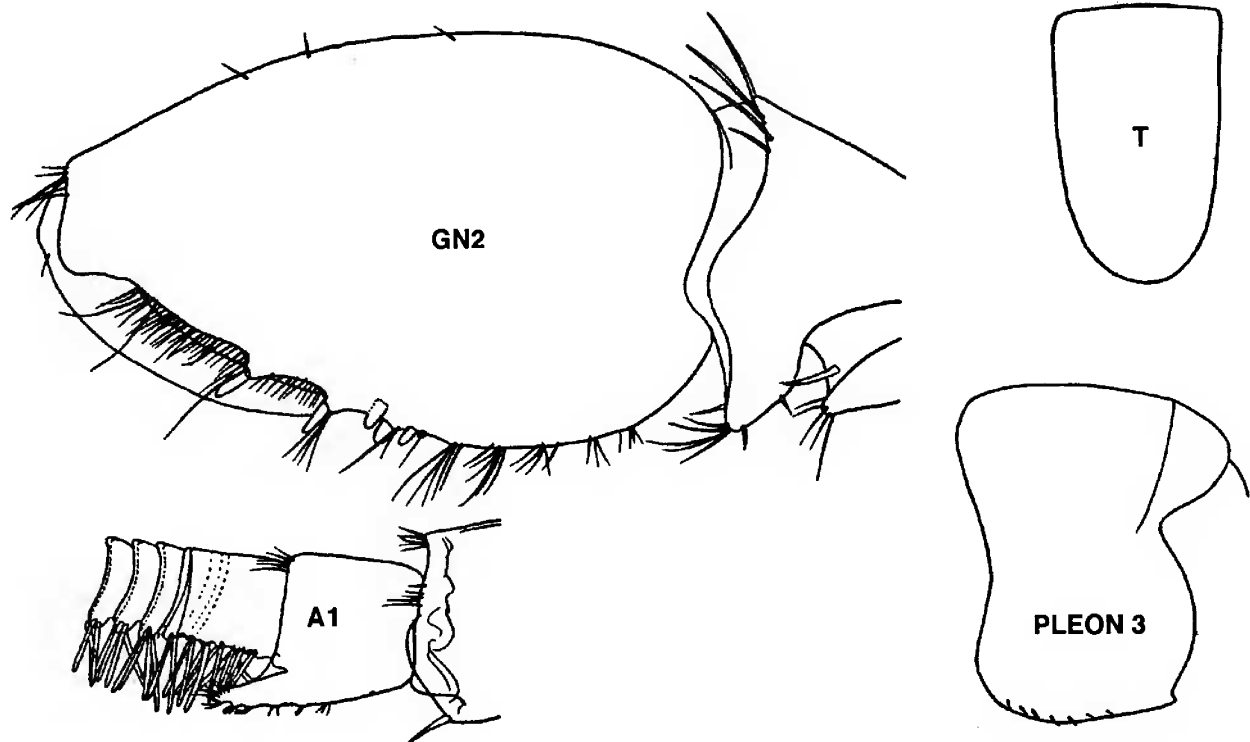


FIG. 9. *Calliopius pacificus*, new species. Off Depoe Bay, OR. Male (10.0 mm) (after Barnard, 1954).

July, 1961: A19 (45); A12 (1); A175 (10); A7 (Ketchikan) (3 specimens, slide mount).

BRITISH COLUMBIA.

Queen Charlotte Islands. ELB Stns, July-Aug., 1957: H8a (NE Graham Is.) (3); H5 (1); E1 (3); E14b (1 female ov.); E17-18 (NE Moresby Is.) (1).

North-central mainland coast. ELB Stns, July, 1964: H10 (Hecate Strait) (10); H7 (2); H4 (> 2); N11 (Queen Charlotte Strait) (25).

Georgia Strait. ELB Stns, July-Aug., 1955: M2 (N. of Powell R.) (2); M5 (Selma Park) - 3 specimens, slide mounts including male (14.3 mm), **holotype**; 2 female ov. (10.0 mm), **allotypes**; M8 - 1 female ov.; M11 - 1 female ov.; G2 - 10 females; Fraser R. Delta, May, 1979 - 1 female ov.

Vancouver Island, inner coast. ELB Stns., 1959: V17 (N. Johnstone Strait) - 1 female ov.; N18 (4); J. Carl Stn (Saturna I.), Aug., 1955 - 40 specimens; R. Long Stn, Saltspring Is. 1977 - 1 female.

Vancouver I., outer coast. ELB Stns, July-Aug., 1959: O3 (Quatsino Sd) (10); O7b (1 female ov); ELB Stn H44 (Bamfield), July, 1964 - 1 specimen.

Juan de Fuca Strait. ELB Stns, Aug., 1955: F4 (7); F5 (6); ELB Stn P716 (Esquimault), July, 1970 - 24 specimens; ELB Stn B5d, May, 1977 - 10 specimens; J. Carl Stn, Victoria, 1949 - 8 specimens; J. Carl Stn (Oak Bay) 1949 - 7 specimens.

WASHINGTON:

San Juan Island. ELB Stn F8, July, 1955. - 1 male, 10 females, 1 slide mount.

Puget Sound. ELB Stns, July, 1966: W5 (Whidbey Is.) (10); W10 (Olympia) (60 females ov.).

OREGON:

ELB Stn W57 (Cape Perpetua), Aug., 1966 - 1 female ov.

Diagnosis. Male (4.3 mm): Body weakly carinate on posterior peraeon and pleon. Head, eye large, subrectangular. Antennae 1 & 2, peduncular segments nearly bare of setae. Antenna 1 slightly shorter than 2; flagellum ~16-segmented; peduncular segment 3, process very short, about 1/3 weakly callynophorate flagellar segment 1. Calceoli small, sparse, in double or triple posterior marginal and submarginal rows.

Mandibular palp segments 2 & 3 subequal; baso-facial cluster of setae lacking?; spine row with 5 blades. Maxilla 1, inner plate with 2 setae; right palp segment 2 very broad. Maxilla 2, inner plate slender, facial seta slender. Maxilliped, outer plate regular, apical margin with ~6 curved setae.

Coxal plates 1-4 small, squarish, gently convex below. Gnathopod propods relatively large and stout; palmar margins very oblique, submarginally setose, with 4-5 strong spines near posterodistal angle.

Peraeopods 3 & 4 relatively strong, dactyls powerful, nearly equal to half length of respective propods. Peraeopods 5-7 increasing distinctly in size distally; peraeopod 5, basis much smaller than in peraeopod 7; basis of peraeopod 7 slightly expanded and angled distally behind, margin distinctly crenulated; segment 4 not broadened; segment 6 distinctly longer than basis.

Pleon plate 2 with scattered single facial and submarginal

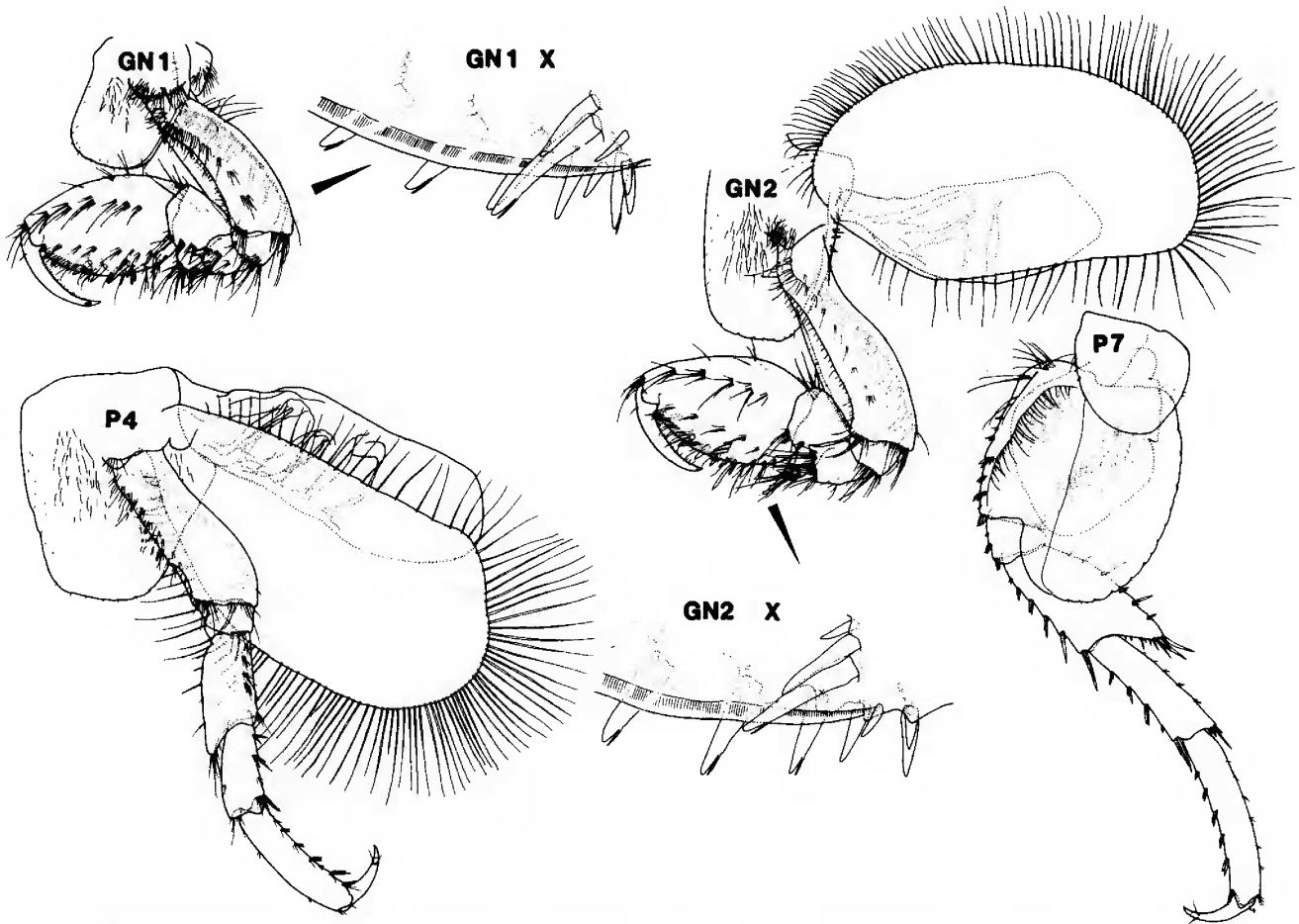


FIG. 10. *Calliopius columbianus*, new species. Brown Bay (V20), V. I., B. C. Female (8.5 mm).

spines. Pleon 3 with 4 stout submarginal spines; hind corner minutely mucronate. Uropod 2, length of outer ramus about 2/3 inner ramus; apical spine elongate. Uropod 3, inner ramus very broad basally, outer ramus, outer margin with spines and a few setae.

Telson, length less than twice width, slightly narrowing distally and rounded behind.

Female (10.0 mm). Dorsum less strongly carinated and gnathopods 1 & 2 distinctly smaller than in male.

Distribution. Known from Prince William Sound, Alaska to the central coast of Oregon. Dominant in inshore waters of bays and estuaries; apparently moderately euryhaline. Usually associated with submerged plants and algae.

Taxonomic commentary. The material of Wailes (1933) may be this species although the author gives no taxonomic details. This less strongly carinated form is not simply the male of *C. carinatus* because of the morphological differences outlined above and in the key (p. 9).

Barnard (1954) provides figures and limited distributional ecology but no taxonomic commentary. His offshore material checks out most closely with *C. pacificus* which is the most common regional form and thus must likely to occur in his limited material from one station.

Calliopius columbianus, new species
(Figs. 10, 11)

Calliopius laeviusculus (Kr.) Barnard, 1971: 10 (part)? Austin 1985: 589 (part).

Calliopius spp. Staude, 1987: 378 (part)?

Material Examined. ~90 specimens at 18 stations:
ALASKA.

Southeastern Alaska. ELB Stns, June-July, 1961: A22 (Sitka Sd) (2); A177 (Dall Is.) (1 male).

BRITISH COLUMBIA

North-central mainland coast. ELB Stns, 1964: H39 (S. Queen Charlotte Sd) (1).

South-eastern mainland coast. ELB Stn V6 (Burrard Inlet), 1978 - 1 female ov., 10 other specimens, slide mount, photo. Vancouver Island, inner coast. Pam Rock (Queen Charlotte Strait) (10 spms., slide mt.), Dec., 1977; ELB Stn V20 (Brown Bay) June, 1959 - Male (9.5 mm), **holotype**; female ov., **allotype**, (slide mounts); ELB Stn., 1955: G4 (2 females, slide); J. Carl Stn, Departure Bay July, 1938 (1); D.V. Ellis Stn, Saanich Inlet, Apr., 1965 (10 specimens, slide mount); Discovery Passage, May, 1965 (10); Stn B7 Victoria (Georgia Strait) (1 female, slide);

Outer coast. Barkley Sd, May, 1965 (1). Uncertain locations.

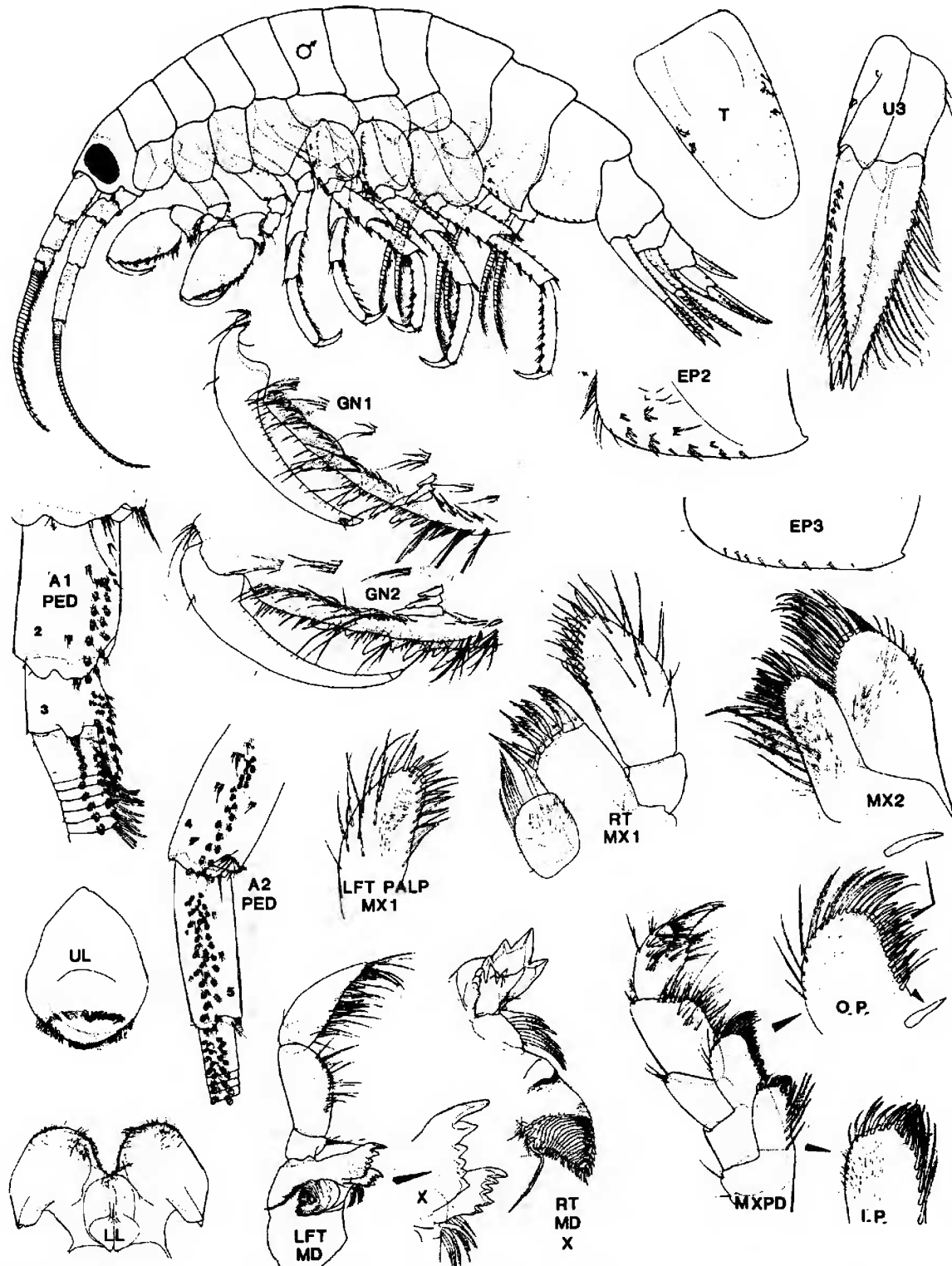


FIG. 11. *Calliopius columbianus*, new species. Brown Bay (V20), Vancouver Island . Male (9.5 mm).

1915-1937 (8 specimens, 2 slide mts.); JFLC Stn, Aug., 1938 (2). Coastal B.C., Apr., 1972 (8); Stn 760012, June, 1976 (1); E.Black Stn, May, 1981 (10, slide mount).

Diagnosis. Male (9.5 mm): Body very weakly carinated, on pleon only. Head, eyes large, slightly narrowing below.

Antennae 1 & 2 moderate; peduncular segments nearly bare. Antenna 1, peduncular segment 3 very short, with strong distal process; accessory flagellum very short, subconical, with 4-6 apical setae; calceoli small, numerous, in 2-4 posterior marginal and submarginal rows; flagellum of ~40 short segments.

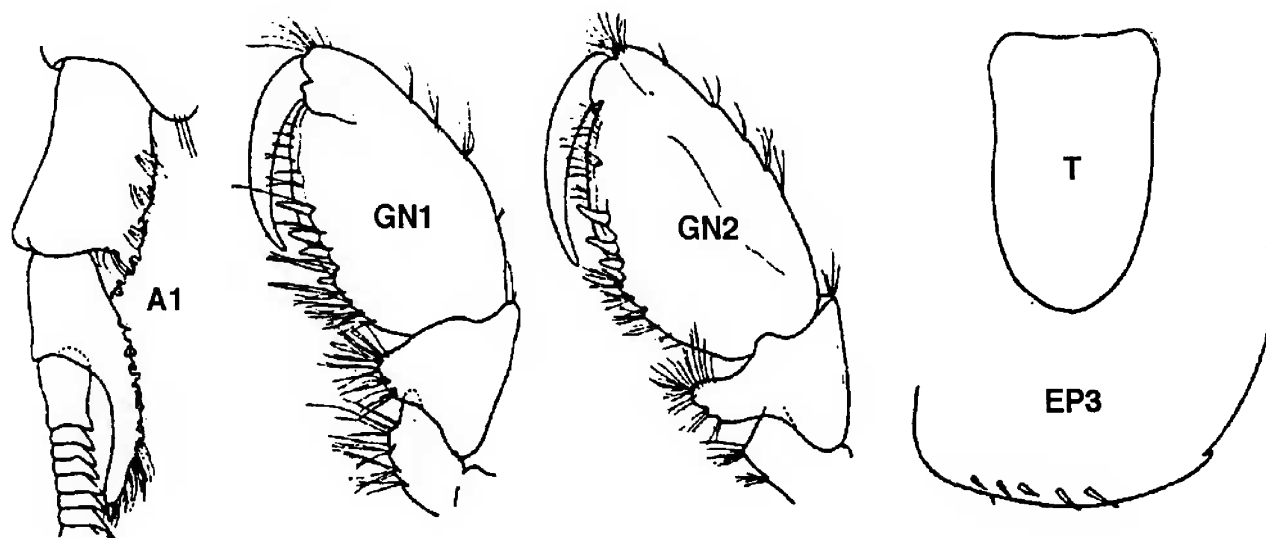


FIG. 12. *Calliopius behringi* Gurjanova. Bering Sea. Female (8-10 mm). (after Gurjanova, 1951).

Mandibular palp segment 3 subfalciform, distinctly longer than segment 2, with weak basal cluster of "A" setae; spine row with 7-8 blades; left lacinia 5-6 dentate. Maxilla 1, inner plate with 5 apical setae; right palp slightly broadened, oblique apex with ~10 stout spines, outermost longest; left palp slender, apex narrowly rounded, with 6-8 short slender spines. Maxilla 2, inner plate with single slender facial seta and several similar proximal inner marginal setae. Maxilliped, outer plate, apical margin with ~12 slender curved setae.

Coxae 1-4 subrectangular, longer than wide. Coxa 4 strongly tapering distally. Gnathopods 1 & 2, propods stout, palmar margins very oblique, longer than posterior margin, with 4-5 medium spines near posterior angle.

Peraeopods 3 & 4 slender; segment 5 not shortened. Peraeopods 5-7 slender, increasing in length posteriorly. Peraeopod 7, basis broadening posterodistally, hind margin not crenulate; segment 4 slender; segment 6 longer than basis, with 8-10 anterior marginal clusters of spines; dactyls slender.

Pleon segment 2 with 10-12 doubly or triply inserted submarginal and facial spine clusters. Pleon 3 with 7-8 submarginal spines; hind corner weakly acuminate. Uropod 1, rami slender, unequal, shorter than peduncle. Uropod 2, outer ramus 2/3 length of inner ramus, apical spines short. Uropod 3, inner ramus broad, both margins setose and spinose; outer ramus with outer marginal spines and setae.

Telson length 1.8 X basal width, narrowing distally, apex broadly rounded.

Etymology. The species name reflects its centre of distribution along the coast of British Columbia.

Distributional Ecology. Occurring sparsely from south-eastern Alaska (Sitka) to southern Vancouver Island, BC (Victoria), from the swash zone along rocky, surf exposed shores, in variable (but mainly higher) salinities, subtidally to depths of 160 m, and deeper off Oregon (Barnard, *loc. cit.*)

Taxonomic commentary. *Calliopius columbianus* is most similar morphologically to *C. behringi* (Fig. 40, p. 60). These character states include the relatively smooth dorsum, elongate, multi-calceolate antennae, and strongly expanded bases of peraeopods 5-7. Relatively little variation was noted in instar sizes throughout its range. The species may occur in deeper water off Oregon (Barnard, 1971).

Calliopius behringi Gurjanova
(Figs. 12, 13, 14)

Calliopius behringi Gurjanova, 1951: 619, fig.420.—Barnard & Karaman, 1991: 313.

Calliopius sp. Fukida *et al.*, 1971: 63, fig. 1?

Material Examined: 1 lot, CMN collections, Ottawa.
ALASKA:

Bering Strait. King Island. P. Slattery Stn., 1989 - female ov., male imm., slide mounts (**fig'd. specimens**).

Diagnosis. Female (8-10 mm - Kamchatka; 15 mm. - Commander Is.). Body carinated mid-dorsally on peraeon 6-7 and pleosome. Head, eyes large, broadly subovate, black. Antennae 1 & 2 intermediate. Antenna 1, flagellum with 40+ short segments; peduncular process elongate, variously curved, extending to flagellar segment 5 or 6; accessory flagellum very short, with 1-2 apical setae; calceoli very small, in 3-6 posterior marginal and submarginal rows.

Mandible, palp segments 2 & 3 subequal in length; segment 3 not falciform, virtually lacking basal cluster of "A" setae; spine row with 7-9 blades; left lacinia 5-6 dentate. Maxilla 1, inner plate with 3 apical setae; palp segment 2 very broadly expanded, nearly truncate apex with 9-10 short, stout spines. Maxilla 2, inner plate with single slender plumose facial seta, and 4 similar proximal marginal setae. Maxilliped, outer plate slightly broadened, apex with 12+ curved setae.

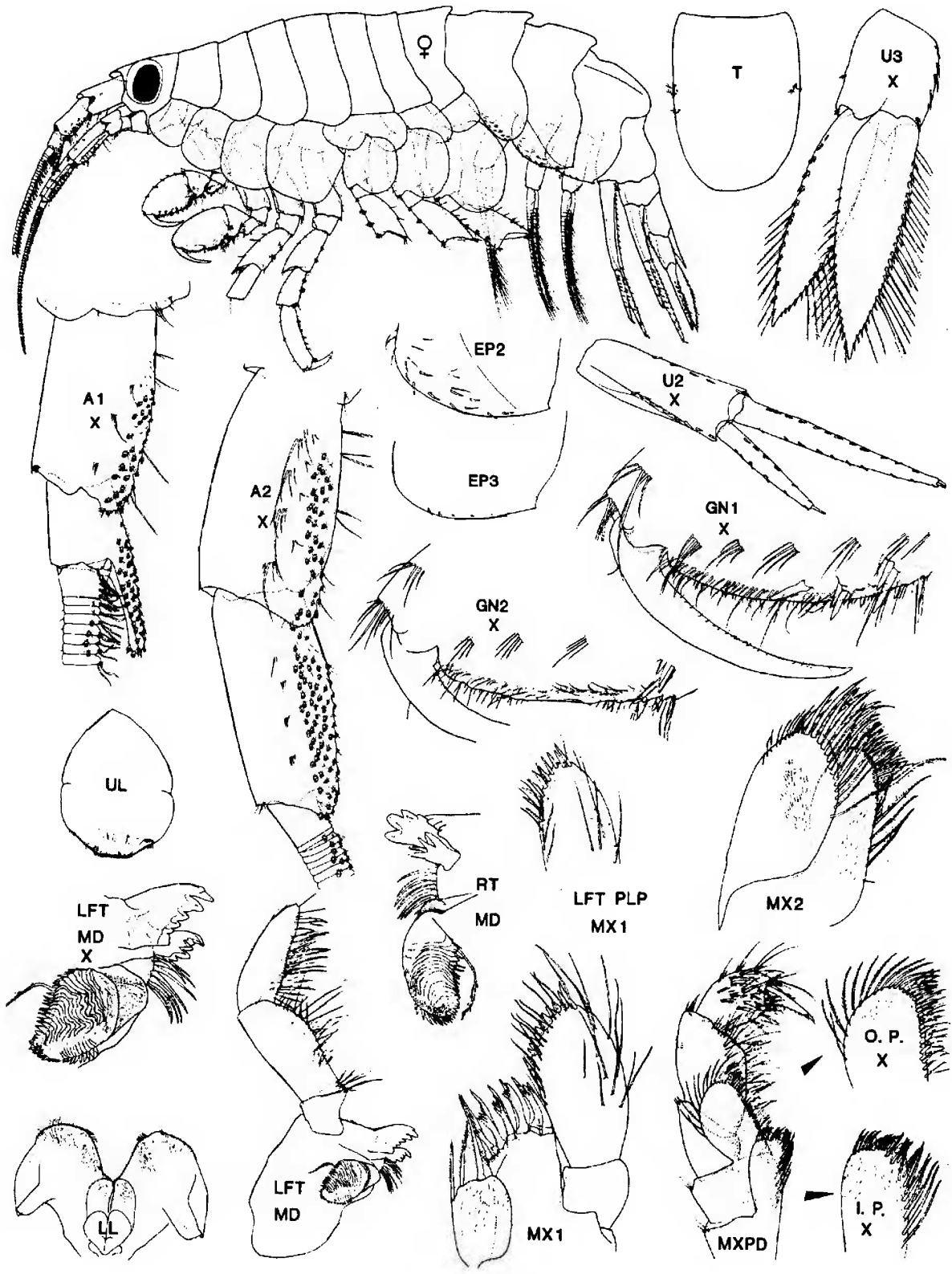


FIG. 13. *Calliopius behringi* Gurjanova. King I., Bering Strait. Female (10.0 mm).

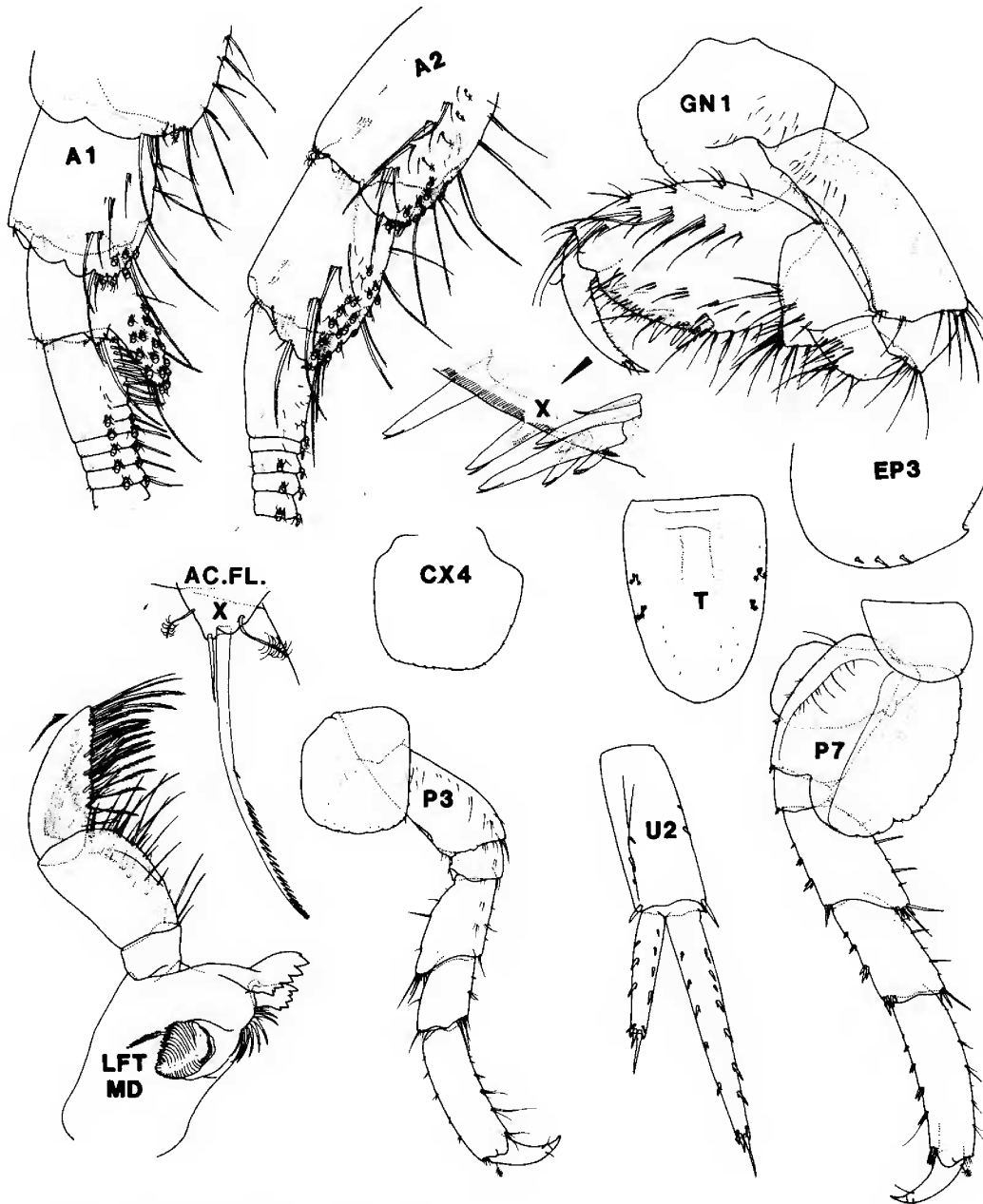


FIG. 14. *Calliopius behringi* Gurjanova. King I., Bering Strait. Male imm. (5.2 mm).

Coxae 1-4 relatively large, broad, lower margins slightly convex. Gnathopods 1 & 2, propods relatively small, with 5-6 distal median facial clusters of setae; palmar margin oblique, shorter than posterior margin, with 2-4 stout spines near posterodistal angle; dactyls relatively long.

Peraeopods 3 & 4 stout, segment 5 shortened, dactyls short. Peraeopods 5-7 homopodous in form, increasing in size posteriorly; bases very broad, strongly convex behind. Peraeopod 7, basis enlarging posterodistally, hind margin finely crenulate; segment 4 slightly broadened.

Pleon plate 2 with a few submarginal and facial spines, mostly single inserted; hind corner subquadrate. Pleon 3 with 5-4 submarginal single short spines; hind corner obtuse. Uropod 1, rami markedly unequal, shorter than peduncle.

Uropod 2, rami slender, length of inner ramus about twice the outer, apices narrowly truncate, spines short.

Telson short, broad, length about 1.4 X width, apex broadly rounded.

Distribution. Bering Sea: Bering Strait, Commander Is., and Kamchatka Peninsula. Littoral zone.

Taxonomic commentary. Antennal peduncles of the immature male specimen are strongly setose posteriorly. The outline figure of *Calliopius* sp. from the Bering Sea region provided by Fukida *et al.* (1971) is not detailed, but is not incompatible with *C. behringi* as described above.

Oligochinus J. L. Barnard

Oligochinus Barnard, 1969b: 98.—Barnard & Karaman, 1991: 329.

Diagnosis. Body smooth. Rostrum short. Eyes medium, narrow, rectangular. Anterior head margin rounded, broadly notched below. Antennae medium; peduncles short, lacking calceoli and/or callynophore. Antenna 1 shorter than 2; accessory flagellum scale-like, with single large stiff apical seta; clusters of aesthetascs posteriorly on alternate flagellar segments.

Lower lip lacking inner lobes. Mandible normal; palp segment 3 subfalciform, shorter than 2; left lacinia 5-dentate?; right lacinia slender. Maxilla 1, palp normal, inner plate 4-setose. Maxilla 2, inner plate with submarginal and single large facial setae. Maxilliped, outer plate small, palp ordinary, not raptorial.

Coxae 1-4 medium, deeper than wide. Gnathopods weakly subchelate, subsimilar; propod and carpus short; palm oblique, posterior angular spines stout.

Peraeopods 3 & 4 short, stout, spinose; segment 5 shorter than 4; dactyls short. Peraeopods 5-7 regularly homopodous, increasing slightly posteriorly.

Pleon plates 2 & 3 shallow, rounded below, lower margin spinose, hind margin serrate. Uropods 1 & 2 short, stout, rami much shorter than peduncles, marginally and apically spinose. Uropod 1, rami subequal. Uropod 2, outer ramus the shorter. Uropod 3 short, rami broad-lanceolate, margins spinose and setose.

Telson short, broad, apex notched. Coxal gills simple, not pleated.

Taxonomic and distributional commentary. *Oligochinus* is apparently monotypic and endemic to the Pacific coast of North America. It is not close to other N. American genera, but is least remote from *Laothoes* (Fig. 39, p. 58).

Oligochinus lighti J. L. Barnard
(Fig. 15)

Oligochinus lighti Barnard, 1969b: 98, figs. 8, 9.—Barnard, 1975: 115, plate 78.—Austin, 1985: 589.—Staude, 1987: 378, fig. 18.13.—Barnard & Karaman, 1991: 329.

Material Examined. Approx. 110 specimens, mostly mature females, in 33 lots. CMN collections, Ottawa.

ALASKA:

Bering Sea. Aleutian Islands (Amchitka Is.). C. E. O'Clair Stn, 1973: B2 (Banjo Pt.) - 3 specimens; IA2(4).

Southeastern Alaska. ELB Stns, July, 1980: S11B2 (NW Chichigof I., north of Sitka) - 2 specimens, photo; S7B3 (2)

BRITISH COLUMBIA:

Queen Charlotte Islands. ELB Stns, 1957: H11 (Masset Hbr.) (2); E21 (North Pt., Moresby I.) - 3 specimens.

North-central mainland coast. ELB Stns., July, 1964: H13 (Prince Rupert) (1); H35 (FitzHugh Sd.) (1).

Vancouver Island, inner coast. ELB Stn, 1955: G13 (north of Nanaimo) - 1 specimen.

Vancouver Island, outer coast. C. Lobban Stns, 1971: CL1022 (Wickaninnish Bay) - 91 specimens, 4 slide mounts; CL1004 (70). C. Lobban Stns., 1971: CL1037 (70); CL1036 (5); 1976-157, Apr., 1976; D. Kittle Stn 73-128, 1972 (8); R. Anderson, 1976 (3); C. Levings Stn, 1975 - 1 female; R. Lee Stn. 5926, 1971 - 1 female.

Vancouver I., south end. ELB Stns, June-July, 1976: B28 (3); B3 (16 specimens, slide mount). ELB Stn, 1970: P704 (4); P719 (Cape San Juan) (2).

Juan de Fuca Strait (Victoria region). ELB Stn, Aug., 1955: F5 (1); D.V. Ellis Stn 5, 1979 (2); R. Long Stn, Victoria, 1977 - 4 females ov.

OREGON:

K. Conlan Stns, Sunset Bay, 1986: 06-9 (6), 06-8 (2).

Diagnosis. Female (8.0 mm)(not fig'd): With the characters of the genus, described as in Barnard, 1969b.

Antenna 1, accessory flagellum with single large stiff apical seta.

Gnathopods 1 & 2, propods subrectangular, posterior margins with 3-4 clusters of setae.

Coxae 1-4, lower margin strongly convex and lined with short spines. Peraeopods 5-7, bases broad, posterior margin strongly convex.

Pleon plates 1 & 2, spinose along lower margin. Uropod 1, outer margin of peduncle with 12-15 stout spines.

Male (5.0 mm): No fully mature males were detected in material examined and are apparently not present in largely summer collections of FHL from Puget Sound (Staude, pers. com.). In the male examined aesthetascs were slightly longer, the slopes of the palms of gnathopods 1 & 2 more oblique, and the telson slightly less deeply notched than in the female.

Distributional Ecology. Recorded sparsely from the Aleutian Islands, Southeastern Alaska (Sitka region), Queen Charlotte Islands, and along the outer coast of Vancouver Island, Puget Sound (Armstrong *et al.*, 1977) and Juan de Fuca strait, south through Oregon to Central California (Pt. Conception). Nestles in *Phyllospadix* clumps and in kelp (*Egregia*) holdfasts, at and immediately below LW level, mainly along surf-exposed and fully marine (>27‰) cold-water coasts.

Taxonomic commentary. Some variation was noted throughout the range of this species, but of a minor nature, not suggesting more than one species is present. The apparent absence of males in summer collections suggests that mature animals are reproducing in late winter and spring in the southern part of its range. *Oligochinus lighti* is a unique species, unlike all other intertidal forms, and differs especially in the notched telson (see phenogram, Fig. 39, p. 58).

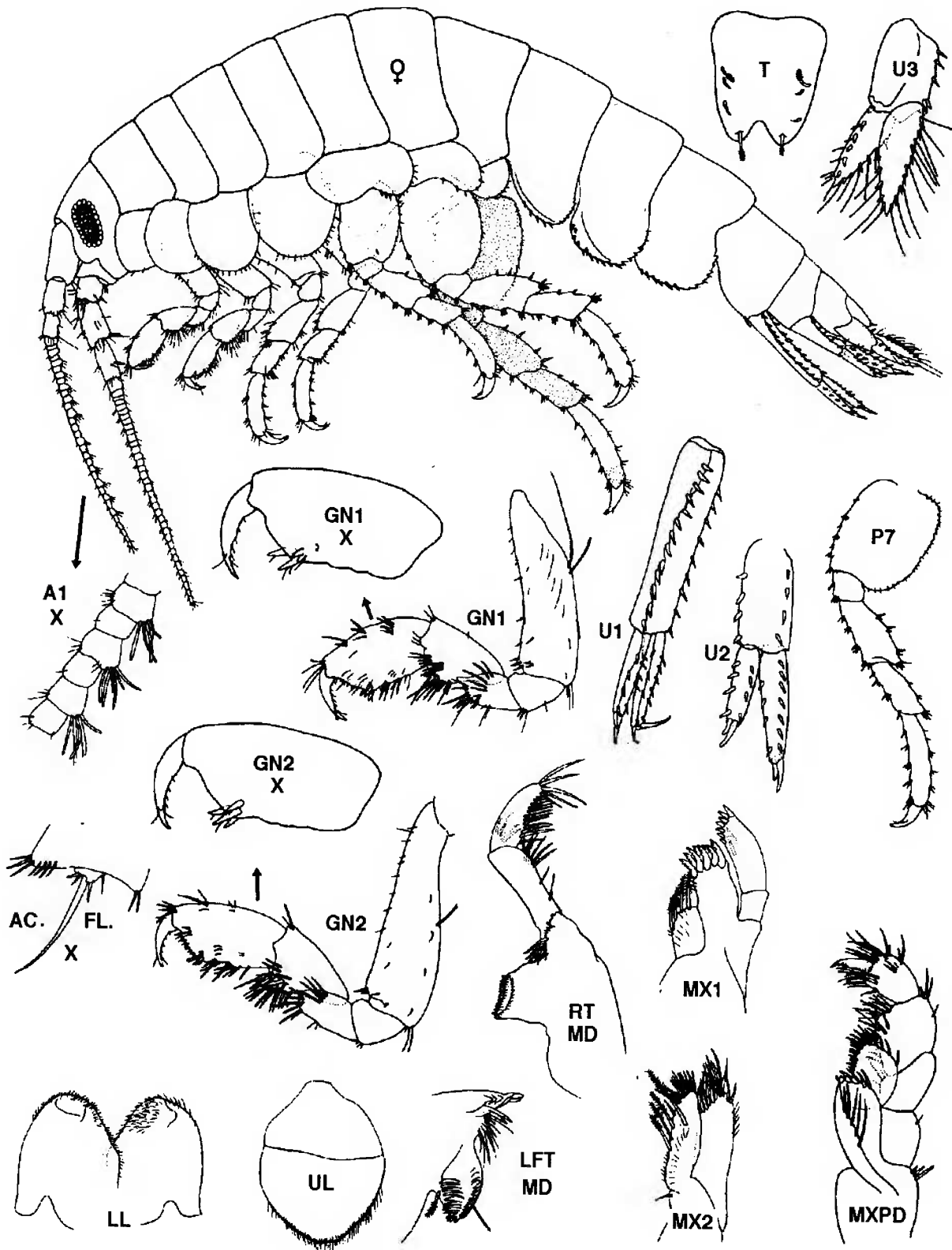


FIG. 15. *Oligochinus lighti* J. L. Barnard. Hazard Canyon Reef, CA. Female (8.0 mm).
(after Barnard, 1969b).

Paracalliopiella Tzvetkova & Kudrjaschov

Leptamphopus G.O. Sars, 1895: 458 (part).—Gurjanova, 1951: 311 (part).

Calliopiella Barnard, 1969a: 175 (part).

Callaska J. L. Barnard, 1978: 38.

Paracalliopiella Tzvet. & Kudrj., 1975: 14.—Karaman & Barnard, 1979: 114.—Barnard & Karaman, 1991: 330.

Type species. *Leptamphopus litoralis* Gurjanova, 1938.

Other North Pacific species. *Paracalliopiella pratti* (Barnard, 1954), Coyle & Mueller, 1981; *P. bungei* (Gurjanova, 1951); *P. shoemakeri*, new species (p. 42); *P. haliragoides*, new species (p. 45); *P. beringiensis*, new species (p. 32); *P. pacifica* Tzvetkova & Kudrjaschov, 1975; *P. slatteryi*, new species (p. 37) (female only); *P. tzvetkova*,

new species (p. 35) (male and female) (= *P. litoralis* Tzvetkova & Kudrjaschov, 1975); and *P. kudrjaschovi*, new species (p. 40).

Diagnosis. Body smooth to strongly carinated mid-dorsally on posterior peraeonal segments and pleon. Rostrum short to medium strong. Eyes large, pigmented, larger in male. Inferior antennal sinus shallow, notch small, inferior head lobe little or not produced anteriorly. Antenna 1 shorter than 2; calceoli lacking. Antenna 1, peduncle short; accessory flagellum minute; aesthetascs clustering posteriorly on alternate flagellar segments.

Upper lip broadly rounded. Lower lip, inner lobes weak or lacking. Mandible, palp segment 3 usually shorter than 2, with basofacial cluster of "A" or "B" setae; left lacinia 5-6 dentate, right lacinia trifid. Maxilla 1, inner plate with 2-8 apical setae; outer plate with 11 apical spines, innermost

KEY TO NORTH PACIFIC SPECIES OF PARACALLIOPIELLA

1. Body strongly carinated on peraeon segments 6 & 7, and pleon segments 1 & 2; uropod 3, inner ramus, inner margin with spines and setae, usually strongly setose 2.
—Body essentially smooth above or weakly carinated only on peraeon 7 and pleon segments 1 & 2; uropod 3, inner ramus, margins spinose, rarely with a few setae 4.
2. Rostrum strong, ~ = antennal peduncle 1; pleon segment 3 strongly carinate.. *P. haliragoides* n. sp. (p. 45)
—Rostrum short, <1/2 length of antennal peduncle 1; pleon segment 3 weakly carinate 3.
3. Gnathopod 2, propod broadening distally; telson subovate, width < length *P. bungei* (Gurj.) (p. 40)
—Gnathopod 2, propod margins subparallel; telson suborbicular, width = length *P. shoemakeri* n. sp. (p. 42)
4. Peraeon 7 and pleon segments 1 & 2 weakly carinate 5.
—Peraeon 7 and pleon segment 1 & 2 essentially smooth above 6.
5. Uropod 3, rami length <1.5X peduncle, inner margins with a few setae; gnathopod 2, carpus with broad shallow posterior lobe; gnathopods 1 & 2, palms subtransverse *P. slatteryi* n. sp. (p. 37)
—Uropod 3, rami length >1.5X peduncle, all ramal margins spinose; gnathopod 2, carpus with narrow, deep posterior lobe; gnathopods 1 & 2, palms oblique *P. pacifica* n. sp. (p. 32)
6. Gnathopods 1 & 2 (female), carpus slender, subequal in length to propod; gnathopod 1 (male) not larger than gnathopod 2 7.
—Gnathopods 1 & 2 (female), carpus short, deep, shorter than propod; gnathopod 1 (male) distinctly larger than gnathopod 2 8.
7. Gnathopod propods, distal facial setae singly inserted; mandibular palp segment 3, length < segment 2. *P. beringiensis* n. sp. (p. 32)
—Gnathopod distal facial setae clustered; mandibular palp segment 3 = 2 *P. tzvetkova* n. sp. (p. 35)
8. Antennae 1 & 2, flagellum medium (25+ segments); gnathopod 1 (female), carpus and propod relatively slender, shallow, carpus length >1.5 X width (depth) *P. kudrjaschovi* n. sp. (p. 40)
—Antennae 1 & 2, flagellum short (<20 segments); gnathopod 1 (female), carpus and propod relatively short, deep, carpus length <1.5 X width (depth) 9.
9. Peraeopods 5-7, segment 4 broad, stout, length slightly longer than width; mandibular palp segment 3, length > segment 2; uropod 3, inner ramus longer than peduncle *P. litoralis* (Gurj.) (p. 30)
—Peraeopods 5-7, segment 4 regular, length ~2X width; mandibular palp segment 3 shorter than segment 2; uropod 3, inner ramus not longer than peduncle *P. pratti* (Barnard) (p. 28)

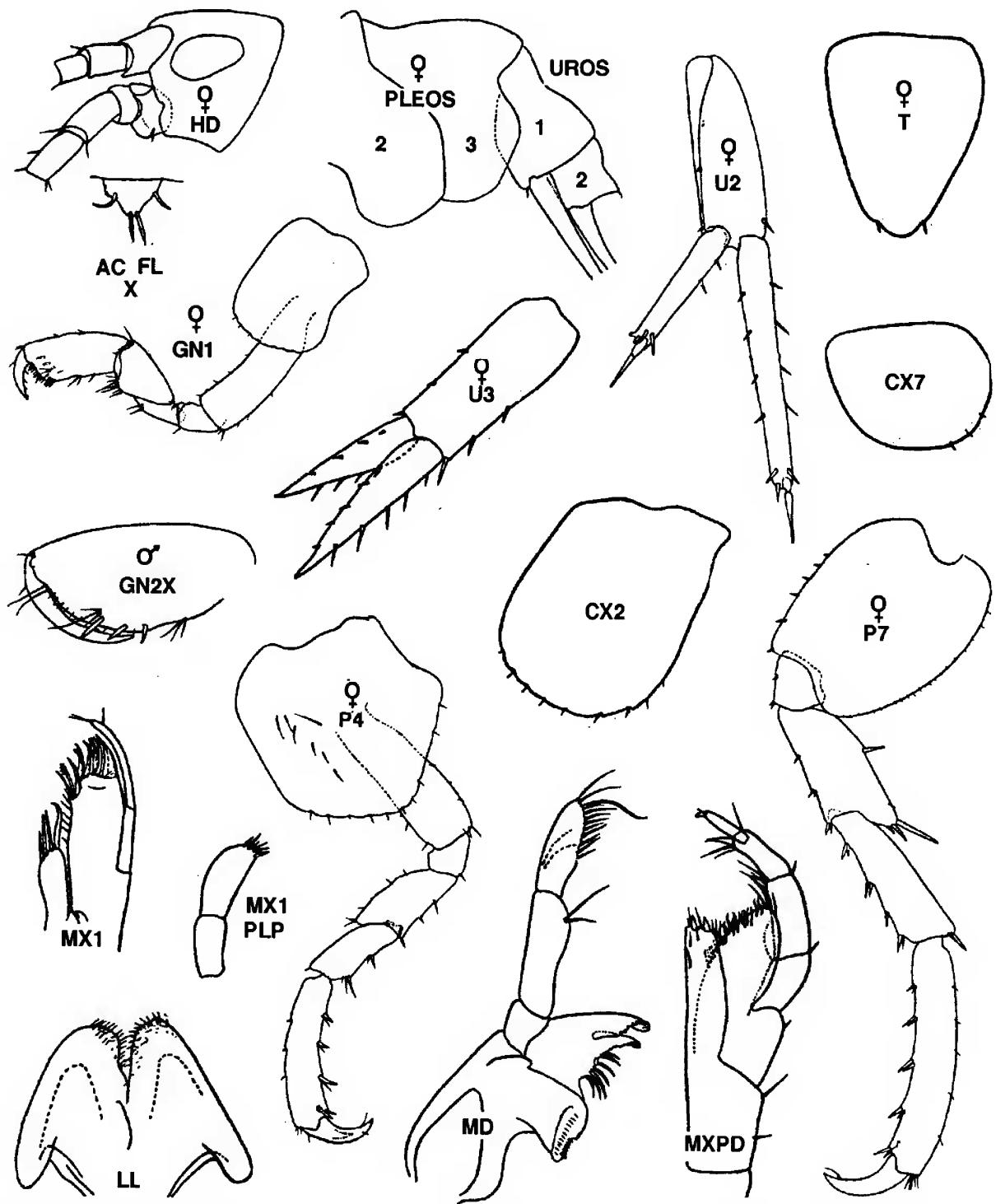


FIG. 16. *Paracalliopiella pratti* (Barnard). Coos Bay, Oregon. Female (5.0 mm) (after Barnard, 1954).

slender, finely pectinate, outermost heavy, coarsely pectinate; palp segment 1 elongate, right palp segment 2 not broadly expanded. Maxilla 2, inner plate narrow, with 3-6 marginal or submarginal facial setae. Maxilliped, inner plate tall, inner margin setose, apex with 2(3) conical spines; outer plate broad, inner margin angled distally and apex medially incised; palp strong, not raptorial in form.

Coxae 1-4 broad, medium deep, increasing posteriorly. Gnathopods 1 & 2 subsimilar; in female: weakly subchelate, propods narrow; carpus slender not longer than propod, hind lobe shallow; in male: gnathopods strongly subchelate, gnathopod 1 usually larger; propods large, deep, with strong palmar spines; carpus short, deep, lobate behind.

Peraeopods 3 & 4 regular, segment 5 often slightly shorter

than 4; dactyls medium. Peraeopods 5-7 regularly homopodous, increasing posteriorly; bases intermediate, rounded behind and distally lobate; segment 4 variously broadened; dactyls medium.

Pleon plate 3, hind margin smooth, rounded, lower margin spinose, hind corner obtuse. Uropods 1 & 2, rami narrowly lanceolate-linear, margins strongly serially spinose; outer ramus distinctly the shorter. Uropod 3, rami lanceolate, attenuating distally, usually longer than peduncle; inner ramus slightly the larger, margins spinose and/or weakly setose. Telson entire, narrowing distally, apex narrowly rounded or truncate.

Coxal gills plate-like, not pleated in male. Brood plates very broad, marginally setose.

Taxonomic commentary. Members of the North Pacific endemic genus *Paracalliopiella* differ from *Calliopi* mainly in the generally smaller body size, more pronounced sexual dimorphism of the gnathopods (weakly subchelate in female), broader and deeper coxal plates, more spinose and less setose uropod 3; shorter distally narrowing telson, and lack of antennal peduncular process and calceoli. *Paracalliopiella* overlaps considerably with *Oligochinus* which also has clusters of aesthetascs on alternating flagellar segments (p. 24). Strongly carinate members may prove distinctive at the subgeneric or perhaps even full generic level (Fig. 41, p. 60).

Paracalliopiella pratti (J. L. Barnard)
(Figs. 16, 17)

Calliopiella pratti (?) J. L. Barnard, 1954: 6, pls. 6, 7.—Barnard, 1969b: 95, figs. 7-8.—Barnard, 1975, figs. 71 (7); 72 (29).—Staude, 1987: 378.

Callaska pratti J. L. Barnard, 1978: 38.

Paracalliopiella pratti (Barnard) Coyle & Mueller, 1981: 10.—Barnard & Karaman, 1991: 331.

Apherusa sp. Park, 1961: fig. 53, & key.

Material Examined: About 1500 specimens in 105 lots. CMN collections, Ottawa (no specimens figured).

ALASKA:

Kenai Peninsula. ELB Stns, June-July, 1961: A130 (15); A136 (4); A129 (4); A131 (70).

Prince William Sound. ELB Stns, June-July, 1961: A93 (1); A92 (2); A121 (32).

Southeastern Alaska. ELB Stns. June-July, 1961: A164 (31); A168 (4); A171-2(2); A18 (50); A25 (4); A23 (15); A83 (Cordova) (1); A81 (8 females, slide mount); A80 (54); A75 (20); A68 (19); A67 (32); A43(10); A66 (1); A61-62 (1); A57 (29 specimens, slide mount); A48 (29); A32 (3); A19 (54 specimens, 2 slide mounts); A20 (6); A30 (23 specimens, 2 slide mounts); A22 (15); A18 (50) A15 (3); (2); A8 (1); A6(3); A3 (Dall Is.) (39). ELB Stns, July 1980: S11B1 (~52 females ov., photo); S11B3 (1); S8B2(7); S7B1 (30); S7B4 (2); S6L2 (1); S5B1 (1); S4B4 (1 female, photo); S4B1

(12); S16B1 (1 female ovig., photo); S19B1 (1); S18B1 (2 females ov., photo); S20B2 (2 females ov.).

BRITISH COLUMBIA:

Queen Charlotte Islands. ELB Stns, July-Aug., 1957: H13 (NE coast Graham I.); H12 (100 specimens, slide mount); H2a (30); W1 (1); H11 (15); H9 (10); H8a (4); H8b (3); W2 (25); H10 (80); H4a (15); E5 (13); W9 (40); W11 (30); E14a (16); E17 (1); E17-18 (8); E9 (3); W15b (9); E25 (Juan Perez Sound, Masset I.) (11).

North-central mainland coast. ELB Stns, July-Aug., 1964: H13(Prince Rupert) (20); H16 (5); H7 (50); H29 (9); H5 (1); H32 (4); H3 (8); H33 (5); H53 (80); H56(17); H50 (11); H57 (40); H35 (30); H1 (55 spms, slide mount); H46, (2); H39 (1); H65 (100). ELB Stns., July, 1959: N1 (50); N6 (20); N11 (30); N18 (3); N16 (100).

Southeastern mainland coast. ELB Stns, Aug., 1955: M2 (3); M11 (White Rock) (19).

Vancouver Island, inner coast. ELB Stns, July-Aug., 1959: V4b (Hope Is.) (40); V5 (20); V7 (25); V10 (35); V11 (43); V17(32); V18 (~100); V19 (32); V20 (70). ELB Stns, May, 1977: B4(3); B4a (60); ELB Stns, Aug., 1955: G2 (46); G4 (Comox) (1).

Vancouver I., outer coast. ELB Stns, Aug., 1955: P4 (5); P6c (20); P8(1); P7 (14); P9 (1). ELB Stns, July, 1959: O1 (Cape Scott) (~20); O4 (14); O3 (4); O5 (2); O11 (~25); O13 (6) ELB Stn, 1975: P5a (13); 5b (5); 5c (4); 5d (17); P17a (2); P24 (1). ELB Stns, July, 1976: B7 (161 spms, slide mount); B3 (47); B5 (4); B12b (4); B11b(1); B13 (fem-ale ov., slide mount); B28 (21). ELB Stns, 1977: B4 (slide mount); B19b (1).

Vancouver I., southwestern coast. ELB Stns, July, 1970: P710 (1); P712 (10); P714 (1). ELB Stn, 1964: H40 (Port Renfrew)(150).

Strait of Juan de Fuca. ELB Stns, Aug., 1955: F6 (22); F5 (30). F4(17); F3(16); F1(30); F2(9); F2a (William Head)(1). ELB Stns, July, 1970: P715 (8); P716 (Esquimalt) (2); P717 (4). ELB Stn B6a, May, 1977 (~100).

WASHINGTON & OREGON:

Strait of Juan de Fuca & Puget Sound. ELB Stns, July-Aug., 1966: W42 (Shipwreck Pt.) (10); W36 (35-40 specimens, slide mount), W35 (~20); W34 (9); W44 (4); W30 (24); W7 (7); W8 (Tacoma) (4).

Olympic Peninsula. ELB Stns, July, 1966: W40 (Mukkaw Bay) (2); W16 (Westport)(1).

Oregon outer coast. ELB Stns, Aug., 1966: W66 (Cape Meares) (3); W61 (1); W60 (~80); W58 (1); W57 (21); K. Conlan Stns, Coos Co., July, 1986: 06-11 (6); 06-2 (many); 06-10 (13 specimens, 2 slide mounts).

Diagnosis. Female (5.0 mm): Body small, deep, smooth above. Eyes very deep, subreniform. Head, rostrum short; anterior head lobe emarginate; inferior antennal sinus broadly notched. Antenna 1 ~ 2/3 length of antenna 2; peduncle very short; segment 3 short; accessory flagellum minute, shallow, rounded apex with 2-3 setae; flagellum ~18-segmented.

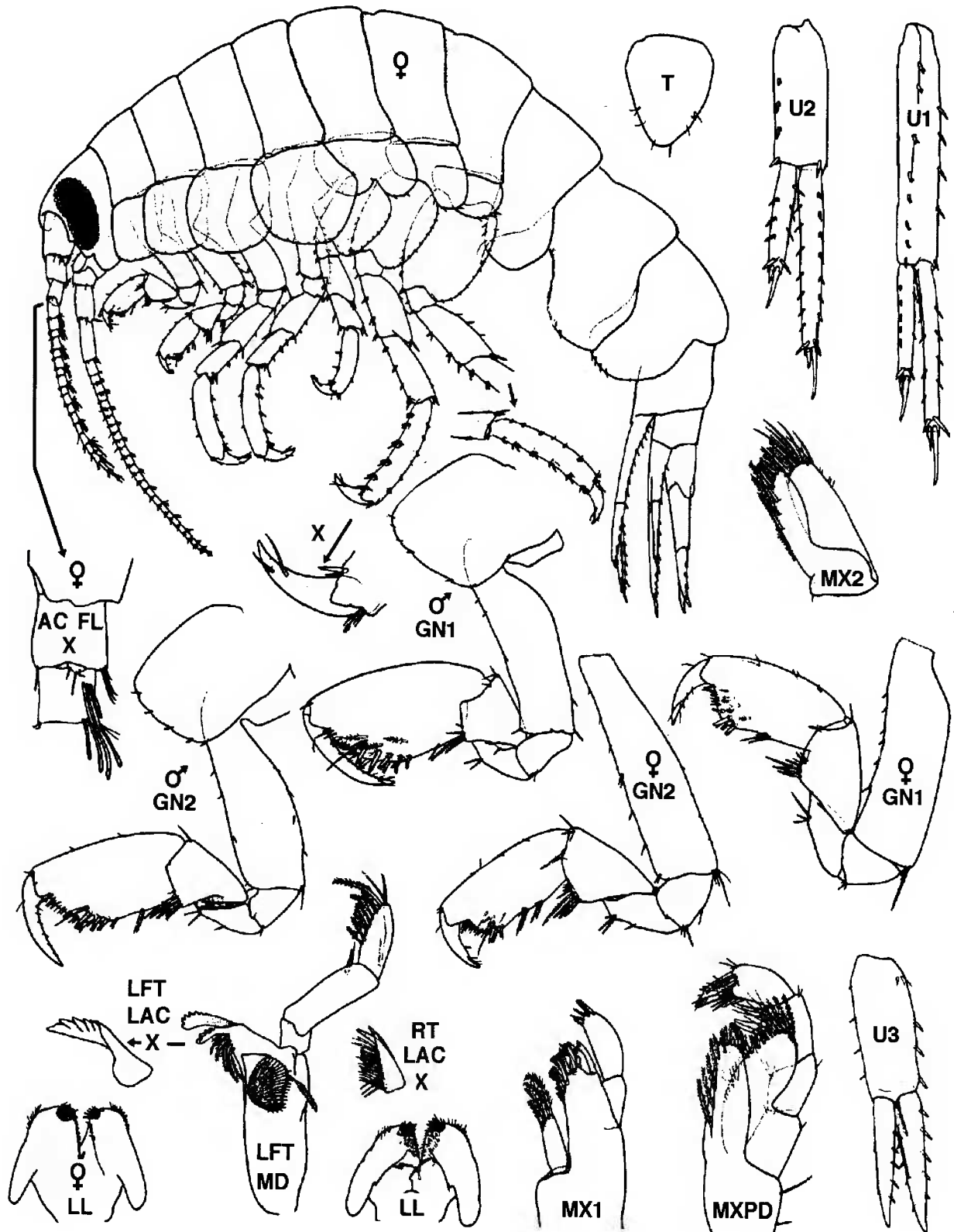


FIG. 17. *Paracalliopiella pratti* (Barnard). Near Carmel Pt., CA: Female (4.2 mm); male (3.9 mm). (after Barnard, 1969b).

Lower lip lacking inner lobes. Mandible, palp segment 3 shorter than 2; left lacinia 5-dentate; right lacinia trifid, body apparently finely setulose. Maxilla 1, inner plate with 4 apical setae. Maxilla 2, inner plate with 3 submarginal plumose setae. Maxilliped, inner plate taller than broad, inner margin with 6-7 plumose setae; outer plate not unusually broadened or distally incised, apex with 6-7 curved setae; palp segment 2 relatively short.

Coxal plates 1-4 relatively short and wide, subquadrate, weakly scalloped below. Gnathopods 1 & 2 subsimilar; propods subrectangular; propod of 1 slighter the deeper and stronger; oblique palm much shorter than straight hind margin that is armed with 1-2 setal clusters; carpus shorter and deeper than propod, hind lobe shallow, setose.

Peraeopods 3 & 4, segment 5 little shorter than 4; dactyls stout. Peraeopod 5 markedly smaller than subequal peraeopods 6 and 7; segment 5 reduced. Peraeopods 6 & 7, bases not very broad, hind margins slightly convex, lower lobes shallow; segment 6 with 5 anterior marginal clusters of spines; dactyl moderately strong.

Pleon plates 2 & 3, lower margins with 4-5 spines; hind corner of pleon 3 broadly obtuse. Uropods 1 & 2, outer ramus distinctly the shorter, dominant apical spine more than twice length of others. Uropod 3, rami spinose marginally, inner ramus not longer than peduncle.

Telson normally spade-shaped, little longer than wide; apex sharply rounded.

Male (to 3.9 mm): Gnathopods subchelate, unequal in size and form; carpus shorter and deeper than in female. Gnathopod 1 the larger; propod powerful, 50% longer than deep, palm oblique, convex, slightly emarginate near midpoint; medial face of propod with 5 stout distal marginal spines and a few singly inserted submarginal setae. Gnathopod 2, propod slightly deeper and stronger than in female, posterodistal angle with 2 clusters of spines, hind margin with single setal cluster; dactyl setulose behind.

Distributional ecology. *Paracalliopiella pratti* occurs commonly from the Kenai Peninsula, Prince William Sound and southeastern Alaska, southward through British Columbia, Washington and Oregon to central California. The species is not uncommon in the outer Puget Sound region (Staude, pers. comm.). The animals occupy a variety of habitats through a wide range of temperature (6.3°C-15.9°C) and salinity, from brackish to fully marine. The species is usually associated with submerged plants and algae, organic debris and other substrata, at and just above the LW level, along both surf-exposed and semi-protected shores.

Taxonomic commentary. On the North American Pacific coast, *Paracalliopiella pratti* is unmistakable in its small size and morphological features. It is most closely related to *P. litoralis* of the Asiatic Pacific coast, but is distinctive in its less robust peraeopods and shorter mandibular palp (see key to species, p. 26, and phenogram, Fig. 41, p. 60).

Paracalliopiella litoralis (Gurjanova)

(Figs. 18, 19)

Leptamphopus litoralis Gurjanova, 1938: 311, fig. 26.—Gurjanova, 1951: 615, fig. 418.—Bulycheva, 1957: 100—Tzvetkova, 1967: 170.

Paracalliopiella litoralis (Gurjanova) Tzvetkova & Kudrjaschov, 1975: 17, fig. 2.—Barnard & Karaman, 1991: 330 (part).

Diagnosis. Female (to 5.0 mm): Body smooth above. Head, rostrum medium. Eyes large, subrectangular. Antennae short, flagella 13-20 segmented. Antenna 1 the shorter, accessory flagellum very short (<1/2 flagellar segment 1), apex rounded, with 2 setules.

Upper lip shallow, rounded below. Lower lip lacking inner lobes. Mandible, palp segment 3 slender, >segment 2. Maxilla 1, inner plate with 4 apical setae. Maxilla 2, inner plate with 6(?) inner marginal setae. Maxilliped undescribed.

Gnathopods 1 & 2 subsimilar; carpus short, hind lobe deep, setose below, much shorter than short propod; palmar margin short, oblique, slightly convex, length ~12 posterior margin of propod that is armed with 2 clusters of setae.

Peraeopods 3 & 4 undescribed. Peraeopods 5-7 stout, increasing posteriorly; bases broad, hind margins convex, weakly crenulated, strongly lobate below; segment 4 distinctly broadened; segment 6, anterior margins with 2-3 spine clusters; dactyls strong.

Pleon plate 3, lower margin nearly bare, hind corner rounded or broadly obtuse. Uropods 1 & 2 undescribed. Uropod 3, inner ramus slightly longer than peduncle, inner margin with 4-5 spines.

Telson medium, subtriangular, apex subacute. Male: undescribed.

Distributional ecology. Recorded authentically only from the intertidal of the northwestern Sea of Japan (Peter-the-Great Bay).

Taxonomic commentary. Gurjanova's original description and illustrations are limited but sufficiently detailed to permit critical distinction from other species treated here. Tzvetkova & Kudrjaschov (1975, Fig. 2) have described a 3.5 mm juvenile lectotype specimen under the name *Paracalliopiella litoralis* (Gurjanova, 1938). However, they also assigned to that species an 8 mm. male and a 10 mm female specimen (Figs. 3 & 4) from the littoral zone of Provideniya Bay, on the Siberian shores of the northwestern Bering Sea. These specimens are here considered very different from Gurjanova's original species, and are redescribed below as *P. tzvetkova*, new species (p. 35). Bulycheva (1957) and Tzvetkova (1967) assigned specimens from Peter-the-Great Bay to *Leptamphopus litoralis* Gurjanova. The description and figure of a 3.5 mm lectotype juvenile by Tzvetkova & Kudrjaschov (1975) (Fig. 19, this paper) agree fairly closely with the original description and figure of Gurjanova (Fig. 18, this paper).

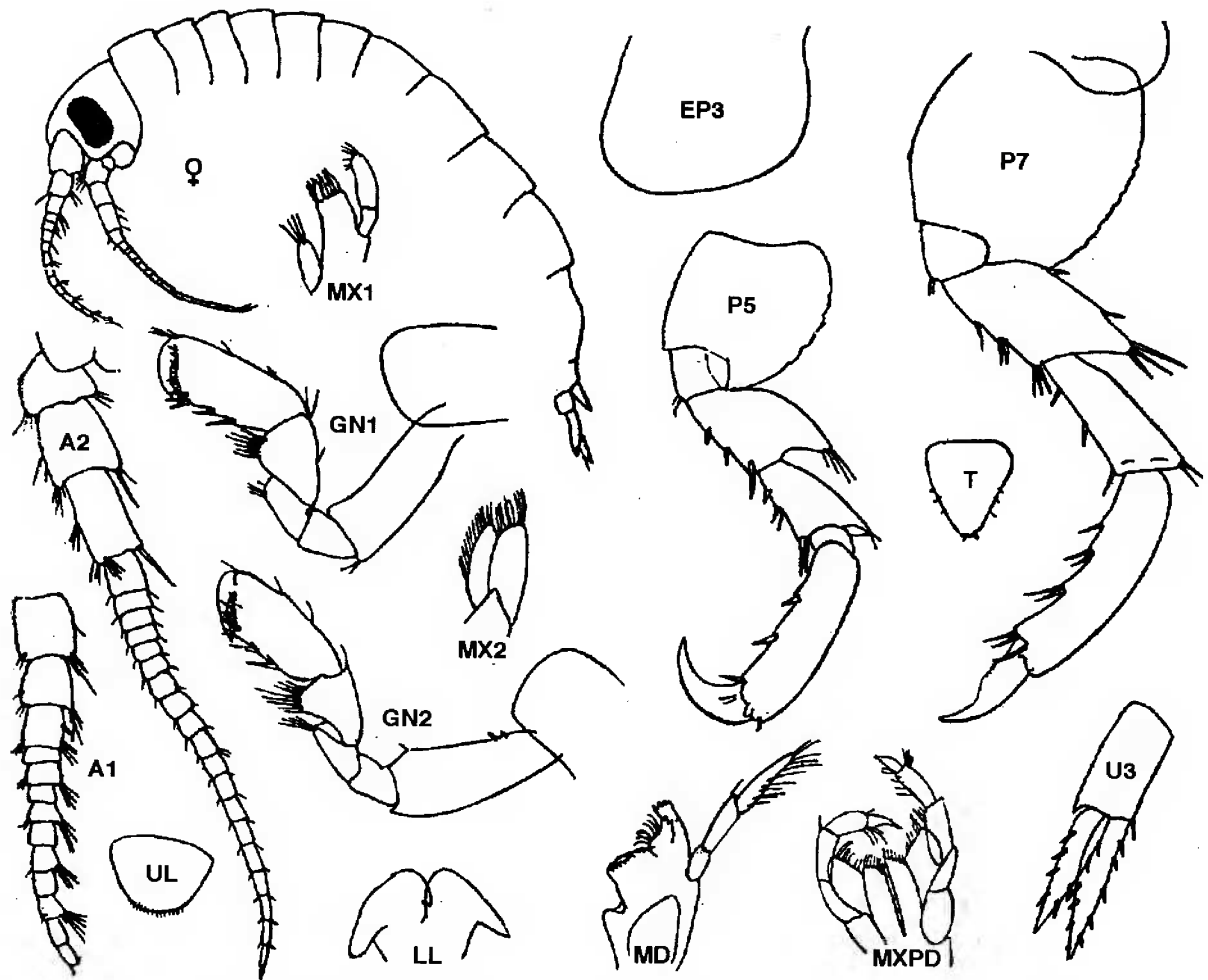


FIG. 18. *Paracalliopiella litoralis* (Gurjanova). Northeastern Sea of Japan to Kamchatka. Female (to 5.0 mm) (after Gurjanova, 1951).

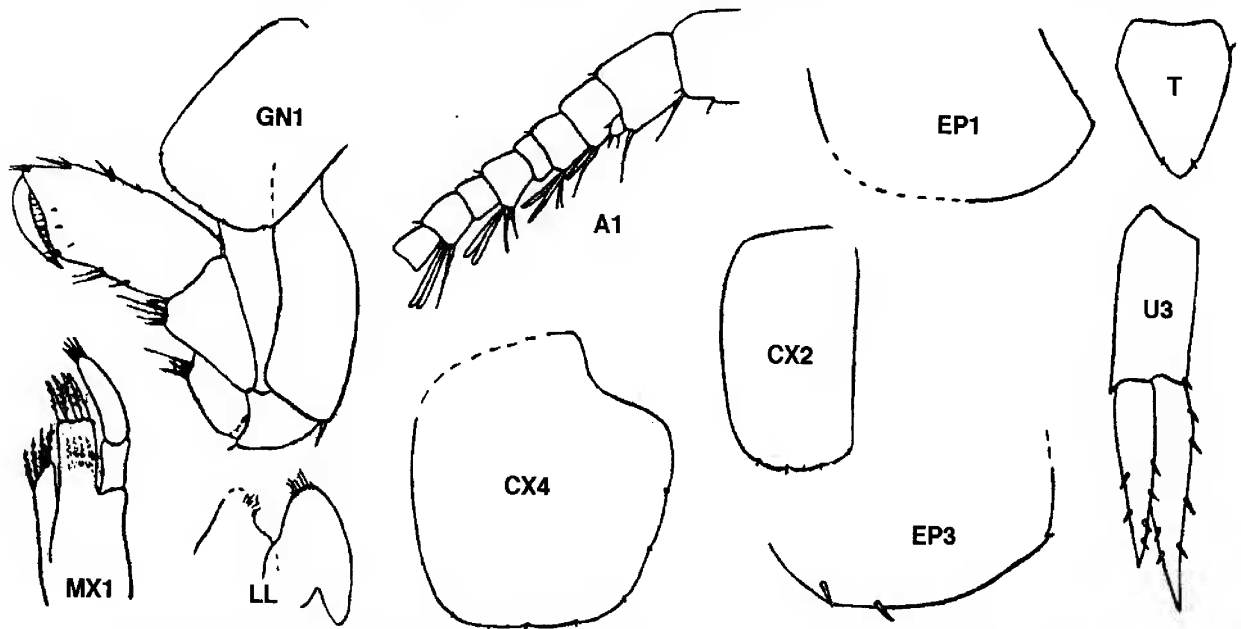


FIG. 19. *Paracalliopiella litoralis* (Gurjanova). Peter-the-Great Bay, Sea of Japan. Lectotype juvenile (3.5 mm) (after Tzvetkova & Kudrjaschov, 1975).

Paracalliopiella pacifica Tzvetkova & Kudrjaschov
(Fig. 20)

Paracalliopiella pacifica Tzvetkova & Kudrjaschov 1975: 15, fig.1.—Barnard & Karaman, 1991: 330.

Material examined.

Aleutian Islands. St. Paul I., P. Slattery Stn., 1983 (2 specimens, 2 slide mounts); Amchitka I., C.E. O'Clair Stn, 1976 - 1 specimen, slide mount. CMN collections, Ottawa.

Diagnosis. Female (to 20.0 mm): Body low-carinate on pleonal and posterior peraeonal segments. Head, rostrum short to medium. Eyes large, dark brown, oblique. Antenna 1 much shorter than 2, both with elongate flagella (28-35 segmented, segments slightly lobate behind). Antenna 1, peduncle 2 not reduced; accessory flagellum minute, with 3 apical setae.

Lower lip with weak inner lobes. Mandible, palp segment 3 shorter than 2. Maxilla 1, inner plate with 5 apical setae; palp slender. Maxilla 2, inner plate broadest medially, inner margin with 6-7 plumose setae. Maxilliped, inner plate stout, apex subtruncate, with 2-3 conical spines, inner margin with several setae; outer plate broad, not disto-medially incised, apex subtruncate, with 8-10 setae; palp strong, segment 2 broad.

Coxae 1-4 shallow, not deeper than broad. Gnathopods 1 & 2 relatively strongly subchelate, subequal; propods expanding distally, palmar margins oblique, convex, merging with hind posterior margin, each with 2 clusters of strong spines at posterodistal angle; inner face distally with few setae; dactyls strong, setulose behind; carpus much shorter than propod, hind lobe of gnathopod 2 deep and rounded, much more pronounced than in gnathopod 1.

Peraeopods 3 & 4 not described. Peraeopods 5-7, segment 4 broadened distally, hind margin wing-like.

Pleon plate 3, with 3-4 lower marginal spines, hind corner obtuse or rounded. Uropods 1 & 2, rami slender, outer ramus shorter, apical spines short. Uropod 3, rami slender, elongate, outer slightly the shorter, both markedly (>1.5X) longer than peduncle, margins distally spinose.

Telson subtriangular, narrowing to an acute apex.

Male: Although the original authors surveyed ~1000 specimens, no male was described. Gnathopods 1 & 2, propods probably larger and carpus shorter and deeper.

Distributional ecology. Common in the middle and lower littoral zone, among algae, on rocky, stony, and pebbly-gravelly sediments, from southwestern Bering Sea (Comander Islands), shores of Kamchatka Peninsula and Kurile Islands to the northwestern Sea of Japan (Posyet Bay).

Taxonomic commentary. As illustrated by Tzvetkova & Kudrjaschov (*loc. cit.*), the female gnathopods of this otherwise primitive species are relatively strongly subchelate, gnathopod 2 slightly larger, with distinctive short, deep, posteriorly lobate carpus.

Paracalliopiella beringiensis, new species
(Figs. 21, 22)

Material Examined.

ALASKA. Bering Sea. Little Diomede Is. (Bering Strait), P. Slattery Stn, 1984 - 2 females ov., slide mount; King I., P. Slattery Stn, 1986 - female (7.3 mm), **holotype**. St. Lawrence I., Southeast Cape, 8 m. - male (6.0 mm), **allotype**; female (7.5 mm), **paratype**; 20 additional male and female specimens, 7 slide mounts. St. Matthew I., P. Slattery Stn, 1983. - 2 specimens, 1 slide mount. CMN collections, Ottawa.

Diagnosis. Female (7.3 mm.): Body dorsally smooth, or with slight humping of pleonal and posterior peraeonal segments. Rostrum medium. Eyes large, reniform-rectangular. Antenna 1 short, little more than half antenna 2; peduncular segments stout; accessory flagellum ~20-segmented.

Lower lip, inner lobes weakly defined. Mandible, palp segment 3 slender, short; segment 2 with 6-8 stout distal setae, and 3 basofacial "A" setae; left lacinia 6-7-dentate. Maxilla 1, inner plate with 7 marginal setae. Maxilla 2, inner plate with 5-6 marginal plumose setae. Maxilliped, outer plate broad, apical margin with 8-10 curved setae, incised medially; inner plate tall, with 11-12 marginal setae.

Coxal plates 1-3 slightly deeper than wide, rounded and weakly scalloped below; coxa 1 not distally flared; coxa 4 deep, much the largest. Gnathopods 1 & 2 subequal; carpus and propod slender, subequal, posterior lobe of carpus shallow, setose; propod with 5-6 singly inserted mediobasal setae, palm short, oblique, with 5 short spines at posterodistal angle; dactyl nearly lacking posterior marginal setules.

Peraeopods slender, dactyls moderate. Peraeopods 3 & 4, segment 5 slightly shortened. Peraeopods 5-7 regularly increasing; bases moderately broad, hind margins nearly straight; segment 4 little expanded behind; segment 6 with 5 anterior marginal spine clusters.

Pleon plates 2 & 3, hind corners weakly acuminate, lower margins with 2-5 spines. Uropods 1 & 2, inner ramus with 8-9 serially paired spines, apical spines short. Uropod 3, rami distinctly unequal, tapering uniformly distally, margins serially spinose; inner ramus longer than peduncle.

Telson narrowing distally to irregularly truncate apex, length nearly twice width.

Male (6.0 mm): Gnathopod 2, propod larger than in gnathopod 1; palmar margin smoothly convex and contiguous with posterior margin, inner and outer margins each with 4-5 medium spines near posterior angle; inner (median) face distally with 6-7 singly inserted submarginal setae; carpus short, deep, apex of hind lobe subtriangular, weakly setose. Telson, apex gently rounded.

Etymology. The species name recognizes the type locality in the Bering Sea.

Distributional ecology. Known only from the northern Bering Sea region (Little Diomede to St. Lawrence I.).

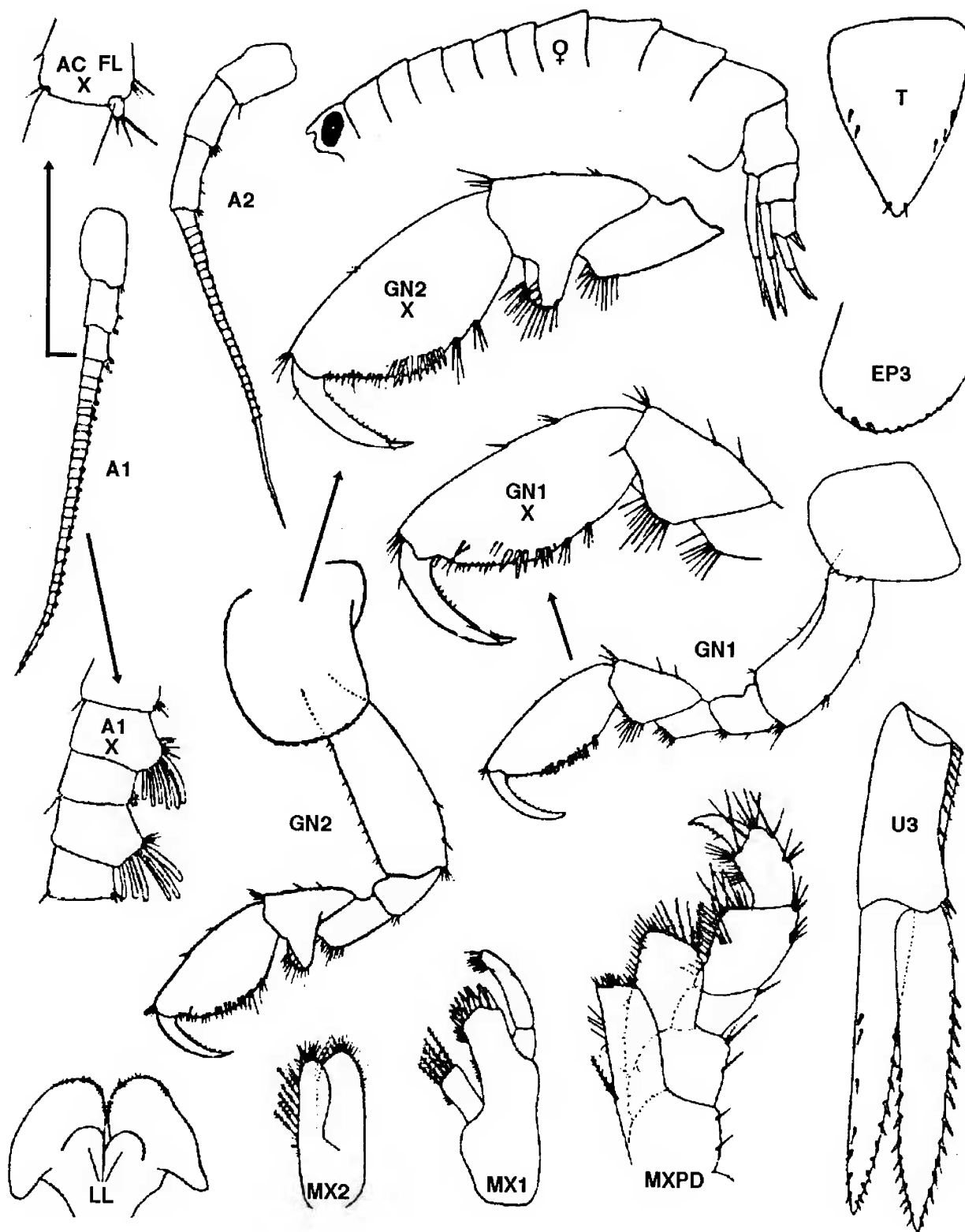


FIG. 20. *Paracalliopiella pacifica* Tzvetkova & Kudrjaschov. Peter-the-Great Bay. Fem. (to 20 mm). (after Tzvetkova & Kudrjaschov, 1975).

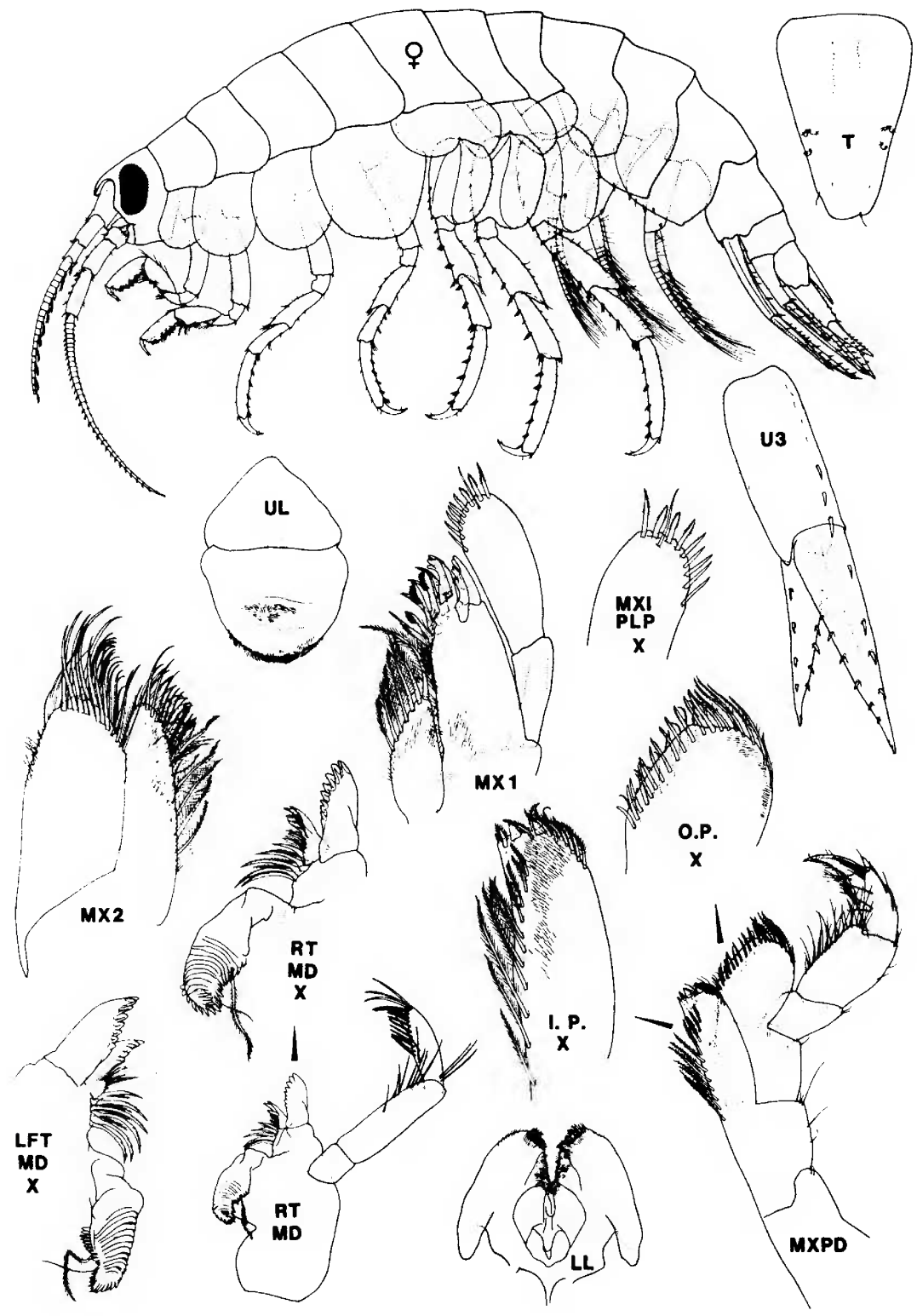


FIG. 21. *Paracalliopiella beringiensis*, new species. King I., Bering Strait. Female (7.3 mm).

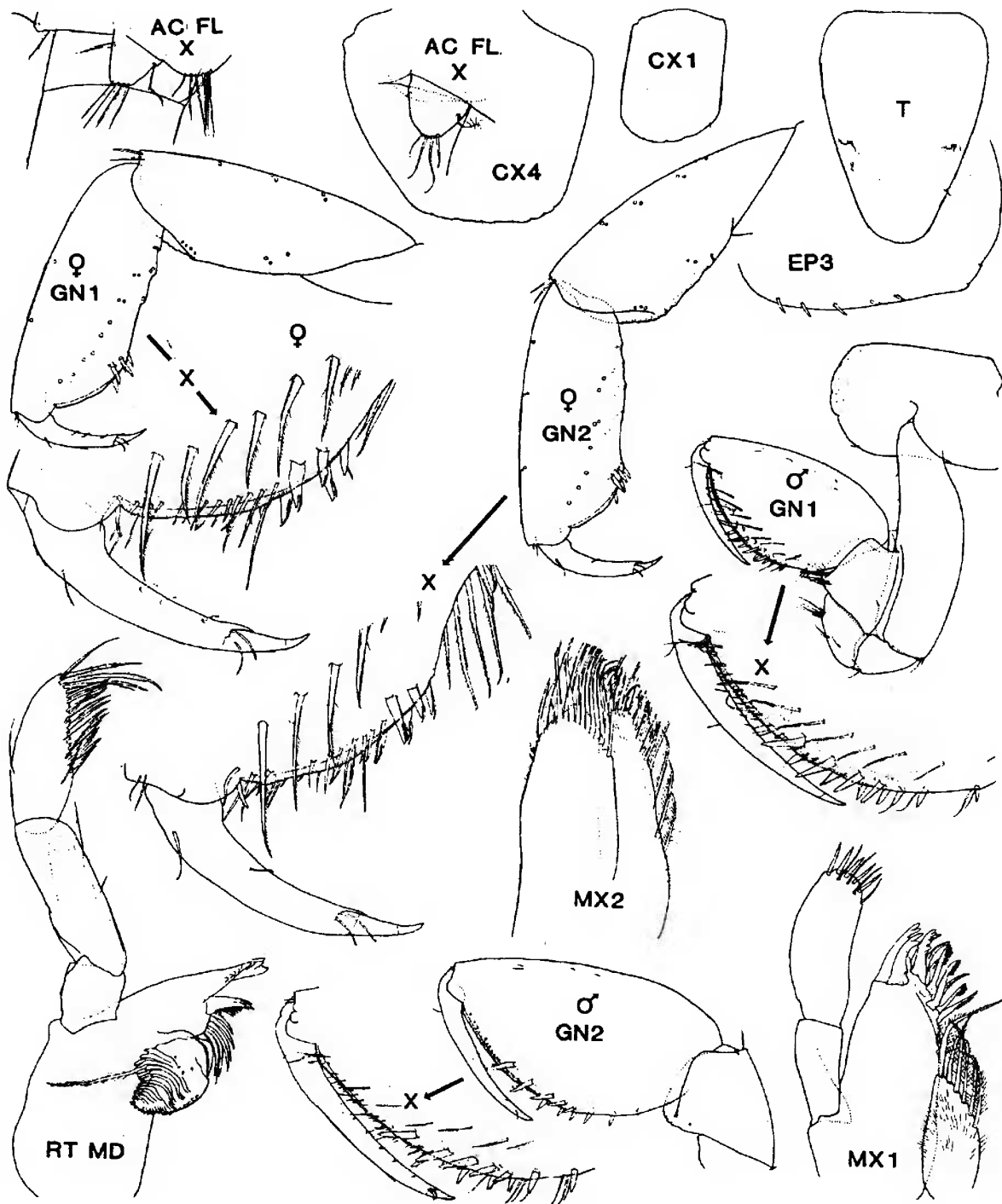


FIG. 22. *Paracalliopiella beringiensis*, new species. St. Lawrence I. Female (7.5 mm); male (6.0 mm).

Taxonomic commentary. *Paracalliopiella beringiensis* is most closely similar to *P. tzvetkova*. The degree of morphological similarity with other regional species is indicated in Fig. 41, p. 60. *P. beringiensis* is plesiomorphic in nearly every character state, especially in the form of the female gnathopods. Morphological variation is slight.

Paracalliopiella tzvetkova, new species
(Fig. 23)

Paracalliopiella litoralis (Gurjanova) Tzvetkova & Kudrjashov, 1975: 17, figs. 3, 4.—Barnard & Karaman, 1991: 330 (part).

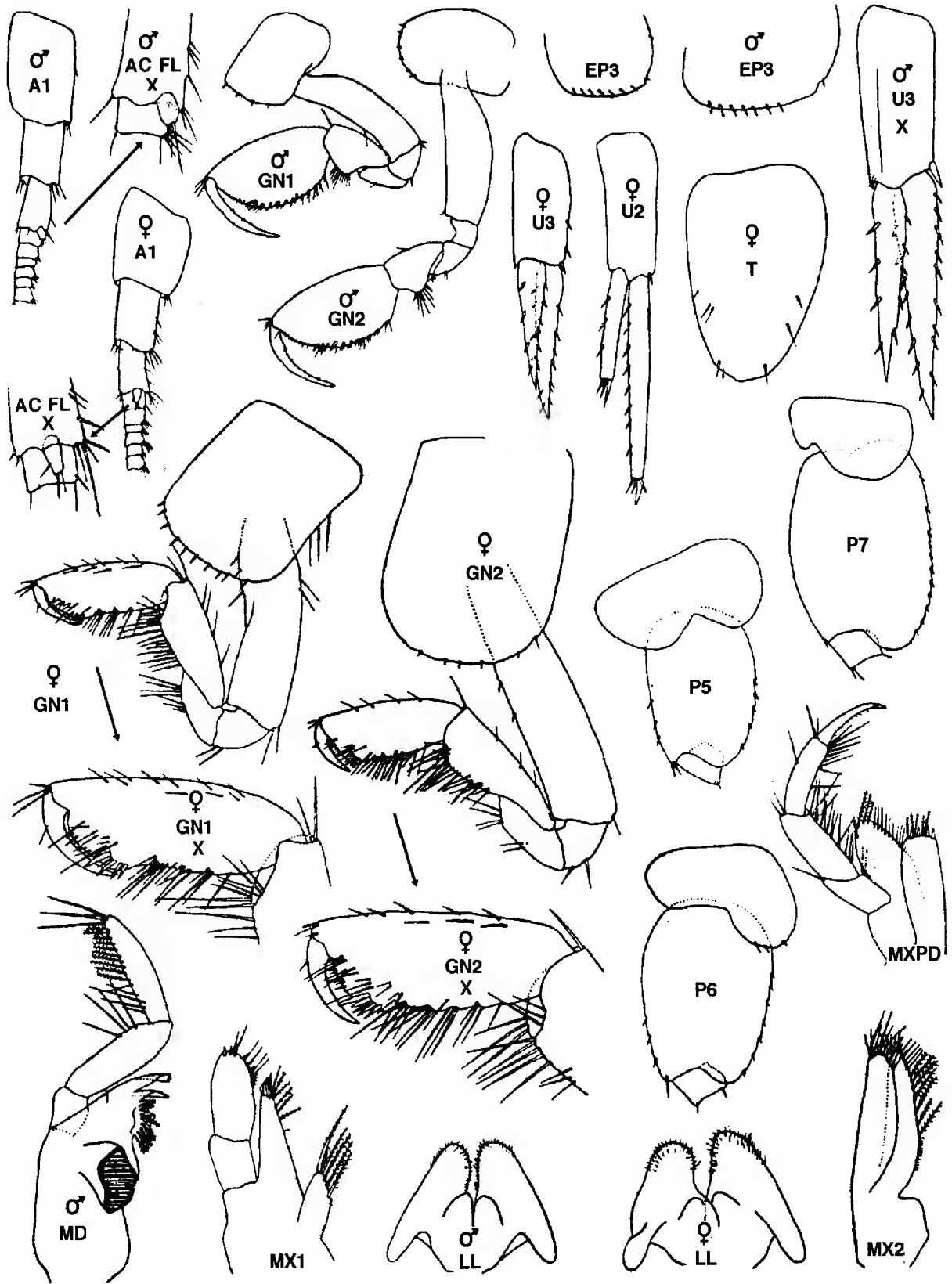


FIG. 23. *Paracalliopiella tzvetkovae*, new species. Provideniya Bay. Male (8.0 mm); female (10.0 mm). (after Tzvetkova & Kudrjaschov, 1975).

Material. The holotype female and allotype male material from Provideniya Bay, as figured by Tzvetkova and Kudrjaschov (1975) is deposited in the Zoological Museum, St. Petersburg. Specimens were not examined by the writers.

Diagnosis. Female (10.0 mm): Body smooth or with slight pleonal mid-dorsal elevations. Rostrum short. Eyes very large, reniform. Antenna 1 distinctly shorter than 2, peduncular segments short; accessory flagellum distinct, length nearly equal to flagellum 1, apex with 2-3 setae.

Lower lip, inner lobes weak. Mandible, palp segment 3 long; segment 2 with 4 inner distal setae; left lacinia 5-dentate, spine row with 8 blades. Maxilla 1, inner plate with 5-6 plumose setae; right palp broadened. Maxilla 2, inner plate with 6-8 marginal plumose setae. Maxilliped, inner plate large, truncate; outer plate broad, distal margin rounded with a few curved setae; palp powerful, dactyl long.

Coxal plates 2-4 large, broad, lower margins nearly straight; coxa 1 not splayed distally. Gnathopods slender; carpus shallow, equal in length to propod; propods, margins subparallel, palmar margin short, oblique, with cluster of posterodistal spines.

Peraeopods ordinary, not elongate, dactyls short. Peraeopods 5-7 regularly increasing, bases medium broad, segment 4 little expanded behind.

Pleon plates 2 & 3, lower margins with 7-8 spines, plate 3 rounded behind, hind corner obtuse. Uropods 1 & 2 not extending beyond 3. Uropod 2, outer ramus short (~1/2 inner ramus), outer margins spinose. Uropod 3, rami slender, unequal, margins with serially paired spines only.

Telson broadly linguiform, apex rounded.

Male (8.0 mm): Eyes very large, covering most of the side of the head. Coxa 2 & 3 relatively small, little larger than coxa 1. Maxilla 1, inner plate with 4 plumose setae.

Gnathopods 1 & 2 powerfully subchelate, 1 slightly the larger; propods deep, palm smoothly merging with posterior margin, 4-5 spines at posterodistal angle; carpus short, hind lobe small. Telson medium, apex bluntly rounded.

Distributional Ecology. The type locality is Provideniya Bay, Siberian coast of northeastern Bering Sea. Material from Bering Strait and other regions of the Bering Sea, south to Prince William Sound, southeastern Alaska.

Etymology. Named in honour of Dr. Nina L. Tzvetkova co-author of the genus *Paracalliopiella*, who has contributed much new taxonomic and ecological information on amphipod communities of the Asiatic North Pacific region.

Taxonomic commentary. As noted above (p. 30), this species was previously included under the name *P. litoralis* (Gurjanova, 1938) by Tzvetkova & Kudrjaschov (*loc. cit.*). However, *P. tzvetkovae* differs from *P. litoralis* in many character states, most of which are relatively plesiomorphic (key, p. 26). *P. tzvetkovae* most closely resembles *P. beringiensis* (p. 32).

Paracalliopiella slatteryi, new species

(Fig. 24)

Material Examined. 2 lots, CMN collections, Ottawa. ALASKA: Bering Sea. St. Paul I., English Bay, one lot only, P. Slattery coll., 1982 - female ov. (9.7 mm), **holotype**; 5 females ov., slide mounts, **paratypes**.

Southeastern Alaska: Elrington I., North Twin Bay, Prince William Sound, K. Conlan coll., July, 1989 - 1 female.

Diagnosis. Female ov. (9.7 mm): Body weakly toothed dorsally on peraeon 7 and pleon segments 1 & 2. Head, rostrum medium; anterior head lobe incised; inferior sinus a narrow slit; lower head lobe slightly produced anteriorly. Eyes very large, reniform-rectangular. Antennae nearly subequal, each with flagellum of 30-35 short segments. Antenna 1, peduncular segment 3 shorter than 2; accessory flagellum short, conical, apex with 5-6 small setae.

Lower lip with very small inner lobes. Mandible; palp segment 3 short; segment 2 with more than 12 short distal setae; left lacinia 5-dentate, right lacinia trifid; spine row with 7-8 blades. Maxilla 1, inner plate with 5 plumose setae; palp slender. Maxilla 2, inner plate with 4-5 marginal plumose setae. Maxilliped, inner plate narrow, inner margin with 9-10 plumose setae; outer plate distally flexed laterally; apical margin slightly emarginate, with 8-9 curved setae.

Coxal plates 2-4 broader than wide, lower margins weakly convex, little scalloped; coxa 4 extremely broad. Gnathopods slender, subequal; carpus shorter than rectangular propod, with marginally setose hind lobe; propod slender, margins subparallel, inner (medial) face with 3 distal submarginal clusters of 2-3 setae; hind margin with 4 groups of setae; palm short, nearly vertical, with 5-6 short spines at posterodistal angle; dactyl slightly overhanging palm.

Peraeopods ordinary; dactyls short. Peraeopods 3 & 4, segment 5 shorter than 4. Peraeopods 5-7 increasing regularly; bases moderately broad, evenly rounded behind.

Pleon segments 1 & 2, lower margins with 6-8 spines; hind margin of pleon plate 3 strongly convex, hind corner obtuse. Uropods 1 & 2 very slender, inner rami with 7-8 serial pairs of spines. Uropod 3, rami subequal, evenly lanceolate, inner margins with a few plumose setae as well as spines.

Telson short, spade-shaped, apex unevenly subtruncate. Brood plates very large, margins with 30-40 short setae. Male: Unknown.

Etymology: The species is named in honour of Peter Slattery, Moss Landing, California, who has contributed extensively to knowledge of amphipod faunas of the Bering Sea.

Distribution. Intertidally, from St. Paul I., Bering Sea, to Prince William Sound, southeastern Alaska.

Taxonomic commentary. *Paracalliopiella slatteryi* appears most closely similar to *P. kudrjaschovi* and *P. pacifica*, all of intermediate phyletic position (Fig. 41, p. 60).

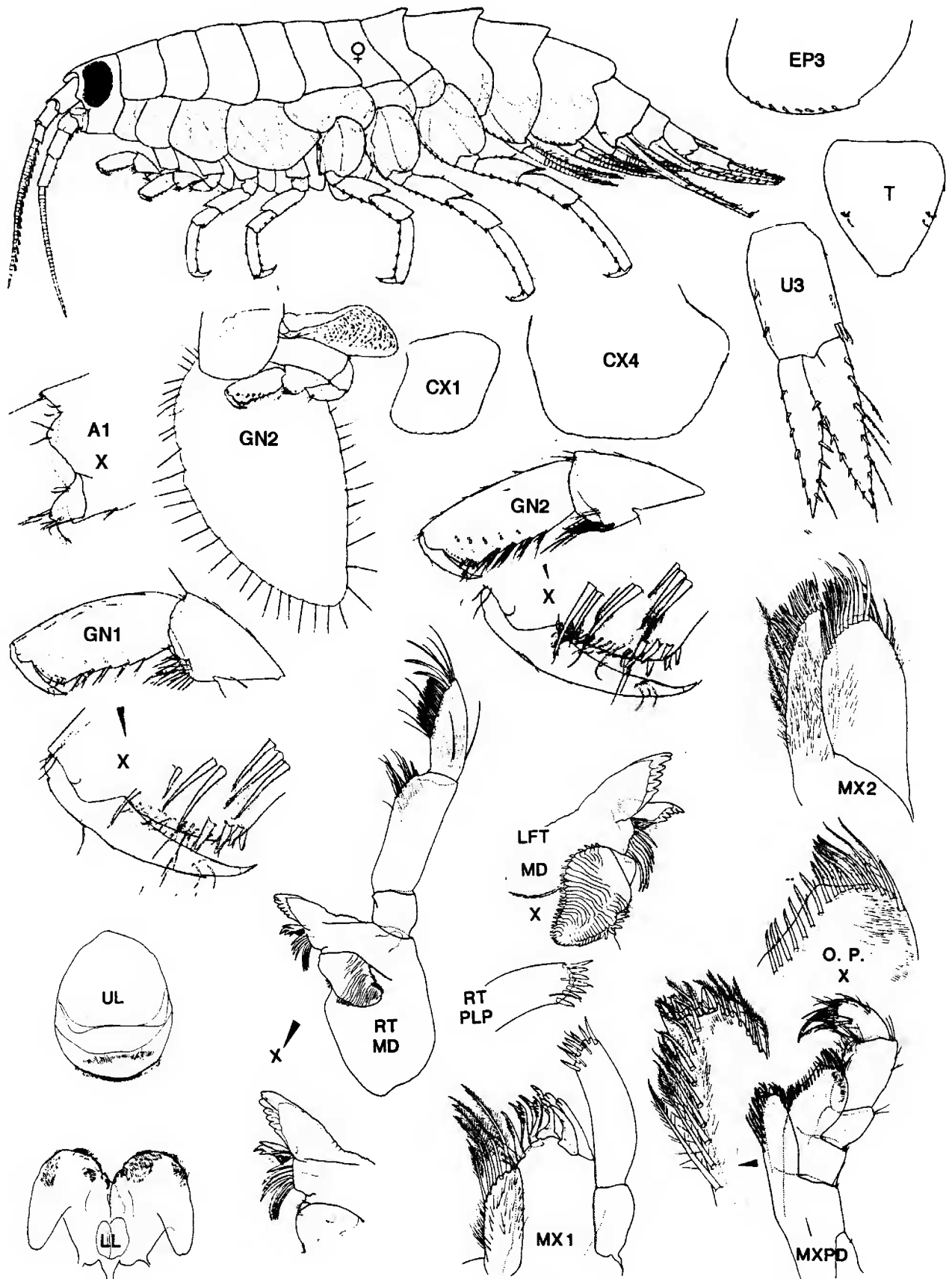


FIG. 24. *Paracalliopiella slatteryi*, new species. St. Paul I., Bering Sea. Female (9.7 mm).

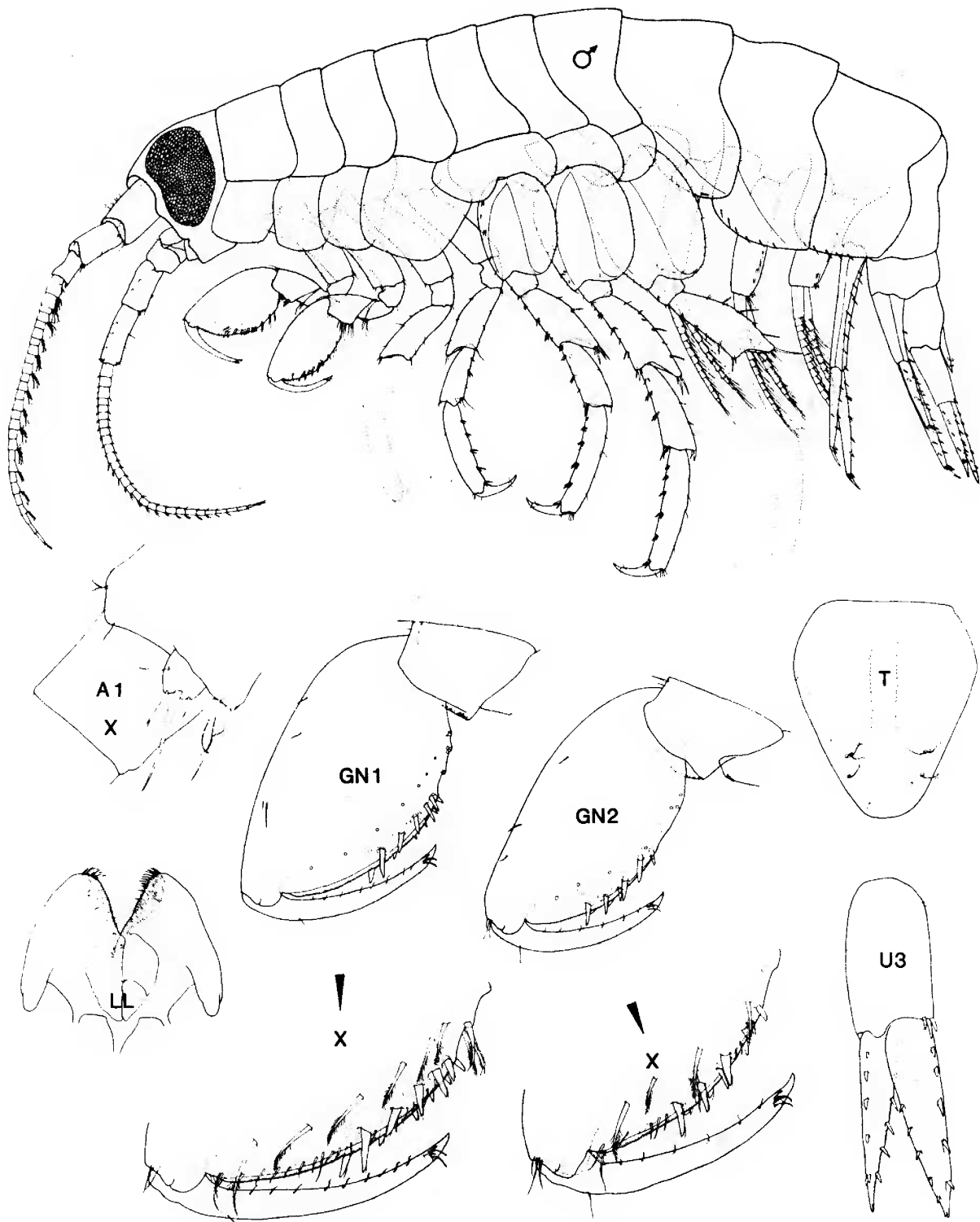


FIG. 25. *Paracalliopiella kudrjaschovi*, new species. Little Diomedé I., Bering Strait. Male (5.0 mm).

Paracalliopiella kudrjaschovi, new species

(Figs. 25, 26)

Material Examined. ~150 specimens in 6 lots. CMN collections, Ottawa.

ALASKA. Bering Sea. P. Slattery coll., Little Diomed I., 1984 - 8 specimens, incl. 2 male, female slide mounts; King I. - 41 specimens, incl. males, females, slide mounts; St. Lawrence I., Southeast Cape - 2 females (ov.), slide mounts. Pribiloff Ids., St. Paul I., English Bay, south side - female (8.2 mm), **holotype**; male (5.0 mm), **allotype**; female (7.9 mm), **paratype**, slide mount; >100 additional spmns. Southeastern Alaska. ELB Stn., 1961: A81 (Hawkins I.) - 1 female spmn, slide mount.

Diagnosis. Female ov. (8.2 mm). Body smooth above, or very slightly raised on pleon segments 1 & 2. Head, rostrum medium; anterior head lobe slightly incised; inferior sinus a short notch; inferior head lobe nearly vertical. Eyes very large, subreniform. Antennae of medium length. Antenna 2 distinctly the longer, flagellum of 22-29 short segments. Antenna 1, peduncle 2 not shortened; accessory flagellum subconical, apex with single large stiff setae and a smaller setule.

Upper lip relatively tall and narrow. Lower lip with weak inner lobes. Mandible; palp segment 3 shorter than 2, with 2 basofacial "A" setae; left lacinia 5-dentate, right lacinia trifid; spine row with 6-7 blades; molar with single lateral seta. Maxilla 1, inner plate with 6 apical setae; palp medium broad. Maxilla 2, inner plate with 3-4 marginal plumose setae. Maxilliped, inner plate tall, outer margin convex, inner margin with 7-8 plumose setae; outer plate relatively broad, deflexed laterally, apical margin slightly incised medially, lined with 7-8 curved setae; palp segment 2 moderately strong.

Coxae 2-4 broader than deep, very weakly crenulated and convex below. Gnathopods slender, subsimilar; carpus shorter than rectangular propod, hind lobes shallow, setose apically; propods slender, margins subparallel, medio-distal submarginal facial setae singly or doubly inserted (not clustered), hind margin with 5 clusters of setae, palmar margin smooth, nearly transverse, with 5-6 spines at posterodistal angle; dactyl strong, tip little exceeding posterodistal angle.

Peraeopods 3 & 4 slender; segment 5 little shortened; dactyl slender. Peraeopods 5-7 regularly increasing posteriorly; bases medium broad and convex behind, lower lobes distinct; segment 4 not broadened; segment 6 with 4-5 anterior marginal spine clusters.

Pleon plate 3, lower margin with 4-5 spines; hind margin rounded to small lower corner. Uropods 1 & 2, rami slender, inner ramus longer than peduncle, one apical spine of each strong. Uropod 3, rami unequal, narrowing regularly; inner ramus longer than peduncle, inner margin spinose.

Telson short, subtriangular, apex subacute.

Male (5.0 mm): Body very low-carinate posterodorsally on peraeon 7 and pleon segments 1 & 2. Eyes large, approximated above. Antennal flagella with 25-20 short segments.

Gnathopods 1 & 2 strongly subchelate. Gnathopod 1, propod distinctly larger and deeper than in gnathopod 2; palm convex, strongly oblique, margin smoothly merging with posterior margin, inner face with 5 marginal spines near posterior angle and 4-5 submarginal setae; dactyl slender, setulose behind; carpus short, relatively shallow, apex of hind lobe obtuse, weakly setose.

Telson basally broad, narrowing distally, apex rounded.

Etymology. The species is named in honour of Dr. V. A. Kudrjaschov, co-author of the genus *Paracalliopiella*, who has extensively investigated amphipod communities of boreal and subarctic shores of the western North Pacific region.

Distributional Ecology. Widely distributed in the north-eastern Bering Sea region, from Bering Strait and Pribiloff Islands south to Prince William Sound. Occurring mainly at and below LW level of hard rock and sand beach interfaces, to depths of 20 m.

Taxonomic commentary. The female of *Paracalliopiella kudrjaschovi* is, in many details, similar to the female of *P. slatteryi*. However, the latter is larger at maturity, the dorsum is distinctly mucronate, the gnathopod propods are shorter and stouter, the inner ramus of uropod 3 is marginally setose, and the telson is relatively long and broad.

As noted above, *P. kudrjaschovi* appears most closely similar to *P. pacifica* and *P. slatteryi* (Fig. 41, p. 60).

Paracalliopiella bungei (Gurjanova)

(Fig. 27)

Halirages bungei Gurjanova, 1951: 611, fig. 414.

Paracalliopiella bungei (Gurjanova) Barnard & Karaman, 1991: 331 (part).

Material examined.

ALASKA.

Bering Sea. Aleutian Islands (Amchitka Is.), K. Chew, G. Tutmark, K. Kimura, 1968 (3); 1969 - 7 spmns, 2 slide mts.

Diagnosis. Female (to 18 mm): The description and illustrations, particularly of the mouthparts (Gurjanova, *loc. cit.*) are limited. Distinguishing features are provided in the key to species (p. 26).

Peraeon weakly carinated on each of peraeonal segments 2-6, more strongly on peraeon 7 and pleon segment 1, and most conspicuously on pleon segment 2, with a raised mid-dorsal ridge on segment 3. Head, rostrum medium; anterior head lobe gently convex; inferior antennal sinus a broad notch. Eye narrow, subreniform. Antennae medium long, subequal; each flagellum with ~40+ short segments.

Accessory flagellum and mouthparts not described, but probably similar to those of *P. shoemakeri* (below).

Coxae 1-4 relatively shallow, broader than deep, convex and weakly crenulated below. Gnathopods 1 & 2 weakly

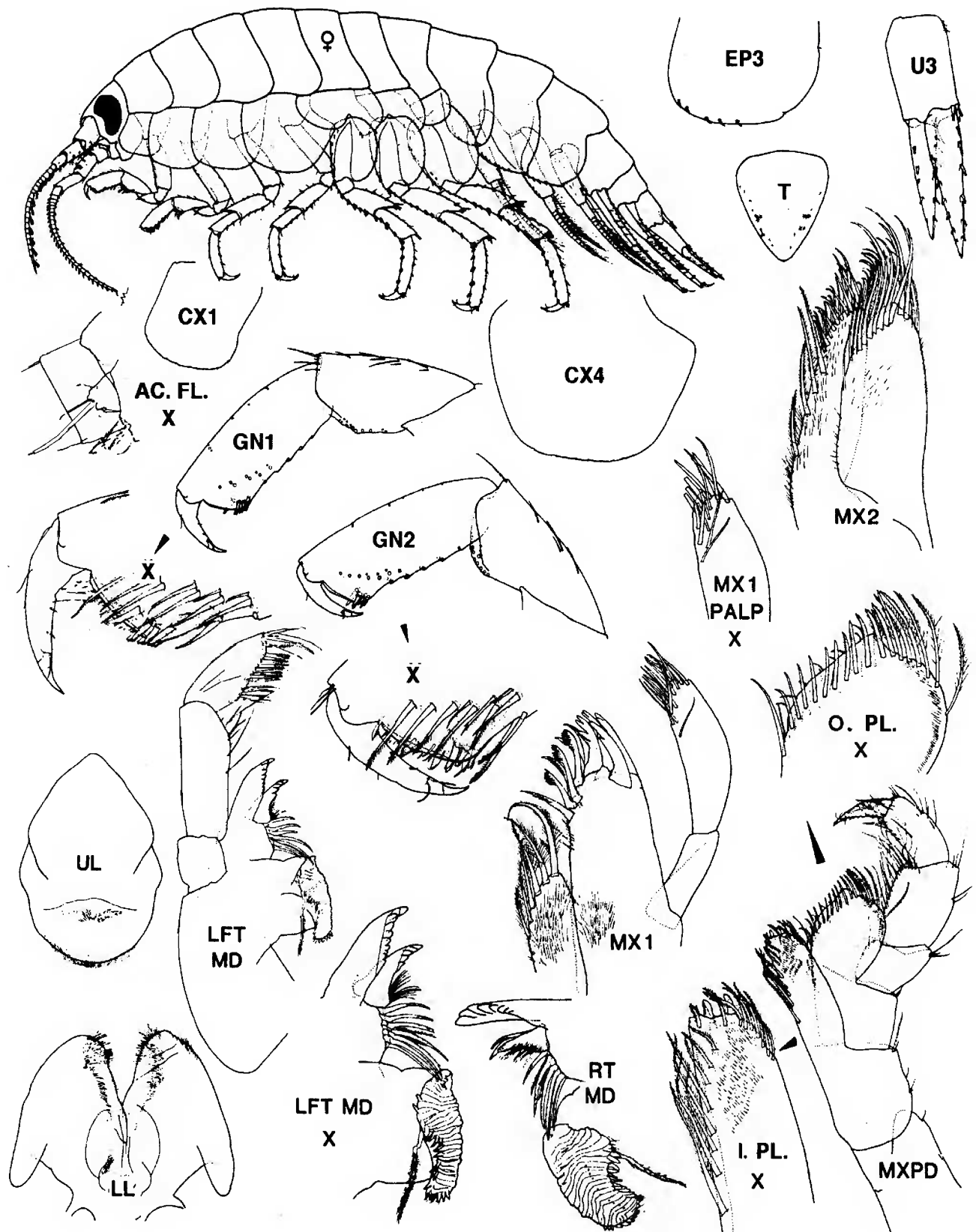


FIG. 26. *Paracalliopiella kudrjaschovi*, n. sp. Little Diomedé I., Bering Strait. Female (8.2 mm).

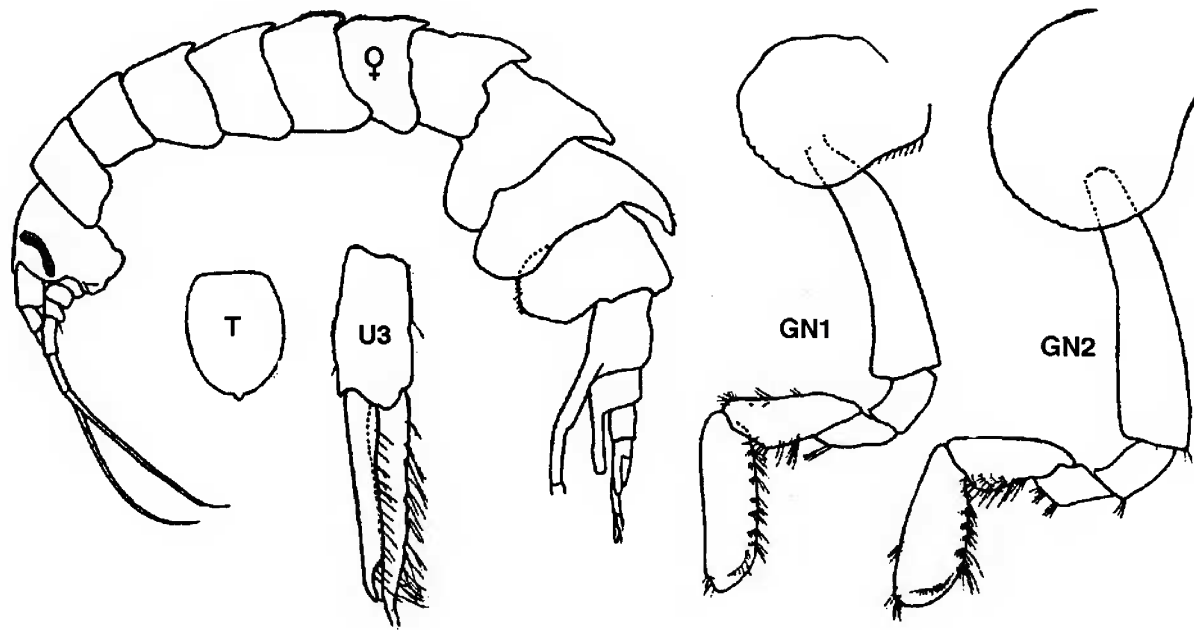


FIG. 27. *Paracalliopiella bungei* (Gurjanova). Bering Sea. Female (18 mm). (after Gurjanova, 1951).

subchelate, with slender elongate carpus and propod, but differing slightly in form and size. Gnathopod 1, propod slender, longer than carpus, margins subparallel, lower margin with 7-8 setal clusters; palm short, convex, oblique; carpus, hind lobe shallow, setose, length about half the anterior margin. Gnathopod 2, propod slightly broadening distally to medium palm that is less steeply oblique than in gnathopod 1; hind margin with 6-7 clusters of setae.

Peraeopods 3-7 undescribed (probably stout, with short dactyls, and similar in form to those of *P. shoemakeri*).

Pleon plates 2 & 3, lower margin spinose; hind corner obtuse, not mucronate. Uropods 1 and 2 slender, incompletely described. Uropod 3, rami slender, narrowing distally, distinctly longer than peduncle, inner margins strongly setose.

Telson broad but longer than wide, rounding apically to small subacute apex.

Male not described.

Taxonomic and distributional commentary.

Paracalliopiella bungei is known from the Bering Sea, and along the eastern shores of the Kamchatka Peninsula, among algae and on fine sand, in depths to 60 m.

Paracalliopiella shoemakeri, new species

(Fig. 28)

Halirages bungei Gurjanova, Shoemaker, 1964: 406, fig. 8.

Paracalliopiella bungei (Gurjanova) Barnard & Karaman, 1991: 331.

Material Examined. The 13.0 mm female specimen from the Bering Sea, illustrated by Shoemaker (*loc. cit.*) is here design-ated as **holotype**, USNM collections, Washington.

Diagnosis. Female (13 mm): Body mid-dorsally carinated, weakly on peraeon 3-5, more strongly on 6-7, very strongly on pleon segments 1 & 2, but reduced to a short ridge posteriorly on pleon 3. Head, rostrum short, wide; anterior head lobe short, slightly emarginate; inferior antennal sinus a broad notch. Eyes narrow, subreniform. Antennae intermediate, subequal; flagella with ~40 short segments. Antenna 1, peduncular segment 3 with slight posterodistal cusp or process; accessory flagellum minute, subconical, with 3 apical setae. Antenna 2, peduncular segment 5 slightly longer than segment 4.

Lower lip simple, lacking inner lobes. Mandible; left lacinia 5-dentate; spine row with 9 blades; palp segment 2 with posterodistal setal cluster; segment 3 distinctly shorter than segment 2, with basofacial cluster of 3 "A" setae. Maxilla 1, inner plate subtruncate, with 5 apical setae; inner plate with 11 apical spines; palp medium broad, apex with 12+ spines and some setae. Maxilla 2, inner plate with 4 inner marginal plumose setae. Maxilliped, inner plate tall, slender, apex with 3 short conical spines, inner margin with 6-8 plumose setae; outer plate large, broad, apex rounded, slightly emarginate medially; palp relatively short, stout, segment 2 distinctly exceeding outer plate.

Coxae 1-4 relatively small and shallow, rounded below. Gnathopods 1 & 2 subsimilar in form and size; propod and carpus slender, weakly subchelate, palms convex, oblique; hind margins with many clusters of short setae, distal median facial setae in clusters of three; dactyls richly setulose behind; carpus, hind lobe shallow, margin setose.

Peraeopods 3 & 4, segment 5 slightly shorter than 4; dactyls short, curved. Peraeopods 5-7 homopodous in form, slightly increasing in length posteriorly; bases broadly rounded, hind lobes not projecting below; dactyls short.

Pleon plates 1 & 2, hind corners weakly acuminate.

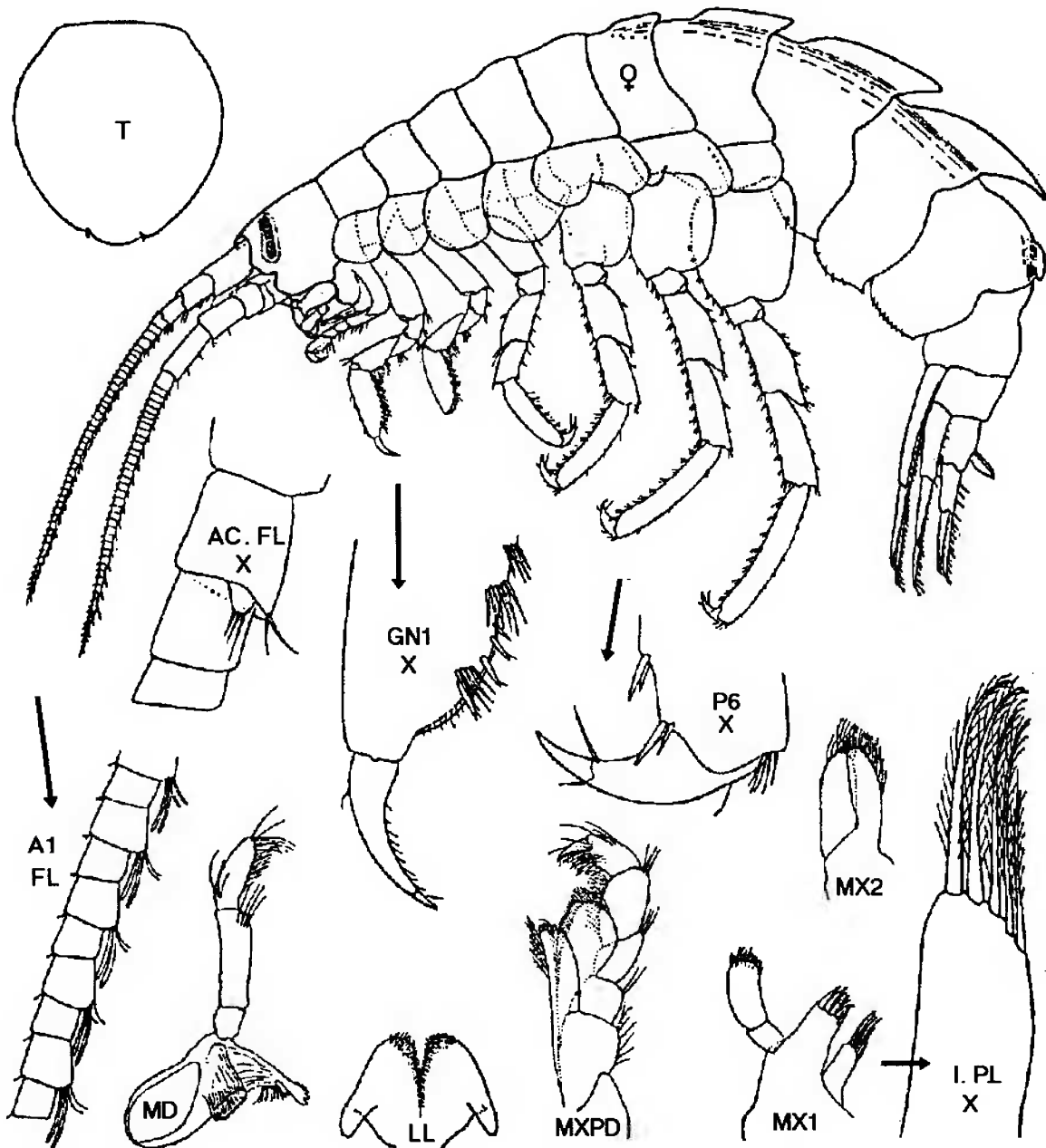


FIG. 28. *Paracalliopiella shoemakeri*, new species. Bering Sea (Commander Is.). Female (13.0 mm). (after Shoemaker, 1964).

Pleon 3, hind corner slightly obtuse. Uropods 1 & 2 slender, outer ramus the shorter; with numerous serial marginal spines and stronger apical spines. Uropod 3, rami longer than peduncle, inner ramus the longer, inner margins setose and spinose.

Telson broad, suborbicular, broadly rounded apically. Male unknown.

Distributional ecology. Records from the Commander Islands, Bering Sea (Shoemaker, 1964) are based on a total of 12 specimens.

Taxonomic commentary. Shoemaker (*loc. cit.*) had synonymized his material with that of Gurjanova's *C. bungei*. However, it is here considered sufficiently different from *C. bungei*, in characters of the key and in size at maturity, to justify separate species recognition. Barnard & Karaman's decision to transfer both forms to the genus *Paracalliopiella*, based solely on the presence of an accessory flagellum, is considered invalid because of the instability of this character state and the need to define calliopiid taxa on the basis of multiple character states (cf., *Calliopi*, p. 7). The strongly carinated *bungei* subgroup, including *P. shoemakeri*, and *P. haliragoides*, may merit separate generic recognition (p. 61).

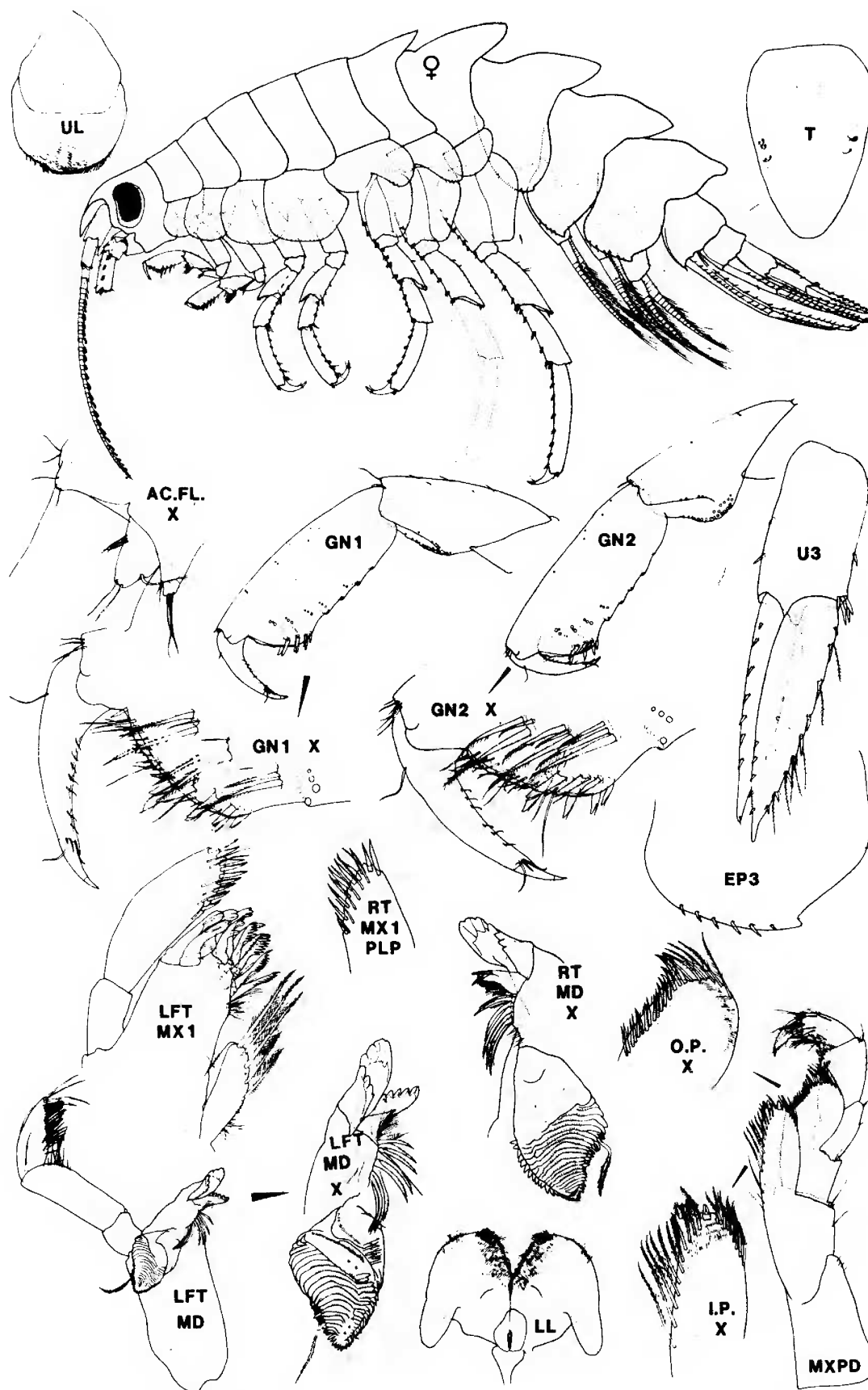


FIG. 29. *Paracalliopiella haliragoides*, new species. Bering Sea. Female (12.5 mm).

Paracalliopiella haliragoides, new species
(Fig. 29)

Material examined. About 100 specimens from a single station. CMN collections, Ottawa.

ALASKA:

Southeastern Alaska. ELB Stn A33, Holkham Bay, at spit off Sumdum Glacier, among stones on sand at LW level, 6.3°C., June 12, 1961. Lot # 1 - Female (13.5 mm), **holotype**; male (9.0 mm), **allotype**; 50 immatures, **paratypes**. Lot #2 - 2 females ov. (12.0 mm), 1 male (8.0 mm), slide mounts, 40 immature specimens.

Diagnosis. Female (12.5 mm). Body strongly carinated mid-dorsally on pereon segments 6 & 7 and pleon segments 1-3. Head, rostrum strong, length about equal to antenna 1, peduncle 1. Inferior head lobe not produced. Eye large, reniform. Antenna 1, flagellum with 40+ short segments, alternate segments with short aesthetascs; accessory flagellum minute, conical.

Lower lip lacking inner lobes. Mandible, spine row with 8 blades. Maxilla 1, inner plate with 3 stout and 2 slender apical setae; outer plate with 11 strongly pectinate apical spines. Maxilliped, outer plate longer than wide, slightly incised medio-apically.

Gnathopods 1 & 2, propods parallel-sided, not broadening distally, inner face armed distally with 3 clusters of stiff setae; palms regularly oblique, with 3-4 clusters of spines at posterodistal angle, extending variously along both sides of the palmar margin.

Peraeopods 3 & 4, segment 6 with 5-6 posterior marginal spine clusters. Peraeopods 5-7, bases normally broad, narrowing distally, lower hind lobes angled or sharply rounded; segment 6 with 6 anterior marginal clusters of short spines.

Pleon segment 2 & 3, lower margins weakly spinose, hind corners acuminate. Uropods 1 & 2, rami unequal, margins serially spinose. Uropod 3, rami medium lanceolate, margins each with 7-9 small spines and short plumose setae.

Telson linguiform, distinctly longer than wide, apex sharply rounded.

Coxal gills and brood plates regular.

Mature male (9.0 mm). Head strongly rostrate. Eye medium, subrectangular. Gnathopods 1 & 2 powerfully subchelate; carpus short, deep, hind lobe triangular; propod deep, palmar margin strongly convex, with ~6 pairs of strong spines. Peraeopod dactyls short, strongly curved. Pleon plate 3, hind corner with small tooth. Telson linguiform.

Etymology. A combining form, referring to its superficial resemblance to some species of the genus *Halirages*.

Distributional ecology. Known only from the type locality, a glacial fiord in southeastern Alaska, among stones over sand at LW level.

Taxonomic commentary. The species is unlike *C. bungei* and *C. shoemakeri* in lacking any trace of dorsal carination

on pereon segments 2-5, in its much stronger rostrum, and in its relatively narrow linguiform telson. At maturity, *C. haliragoides* is similar in size to *C. shoemakeri* but apparently significantly smaller than *C. bungei*.

Halirages Boeck

(see Fig. 30)

Halirages Boeck, 1971: 194.—Stebbing, 1906: 290.—Gurjanova, 1951: 605.—Barnard, 1969a: 177.—Barnard & Karaman, 1991: 322.

Species. 7 world species of which *Halirages nilssoni* Ohlin, 1895 and *H. fulvocincta* (M. Sars) are regional.

Diagnosis. Body mid-dorsally toothed or strongly mucronate, mainly on pleon segments 1 & 2, and posterior pereon. Head, rostrum short, inferior head lobe little produced. Antennae elongate, often calceolate (pontogeneiid type). Antenna 1, peduncle 3 with short distal process; accessory flagellum present, minute; aesthetascs small, singly inserted on alternate segments of primary flagellum.

Mouthparts basic. Lower lip lacking inner lobes. Mandible, palp segment 3 strong, falciform. Maxilla 1, inner plate multisetose; outer plate with 11 apical spines; palp normally 2-segmented. Maxilla 2, inner plate with row of facial setae. Maxilliped plates and palp regular, strong.

Coxae 1-4 medium, lower hind margins serrate. Gnathopods slender, weakly subchelate, not sexually dimorphic; carpus shallow, not longer than propod.

Peraeopods 3-4 slender; dactyls short; segments 4 & 5 subequal in length. Peraeopods 5-7 slender, homopodous, bases not broadly expanded; dactyls short.

Pleon plates 2 & 3, hind corners acuminate, pleon 3 (and often 2) serrate behind. Uropods 1 & 2, rami lanceolate, margins spinose, outer ramus slightly the shorter. Uropod 3 large; rami subequal, lanceolate, margins spinose and setose.

Telson elongate, variable, narrowing distally, apex notched truncate, or acute.

Coxal gills unpleated.

Brood plates large, margins setose.

Taxonomic commentary. The genus *Halirages* is superficially similar to some species of *Apherusa*, and *Paracalliopiella* (Barnard & Karaman (*loc. cit.*)). Differences in the mouthparts, dorsal carination, and generally larger size of component species are the most obvious differences. The generic type species, *H. fulvocincta*, has been recorded from the western Canadian Arctic (Shoemaker, 1920) and the northwestern Pacific south to the northeastern Sea of Japan (Gurjanova, *loc. cit.*). *Halirages nilssoni* has been taken in the Beaufort Sea (Shoemaker, *loc. cit.*) and from the Chukchi and Bering Seas, and northwestern Sea of Japan, in depths to 30 m. (Gurjanova, *loc. cit.*). *H. nilssoni* has a triply carinate abdominal dorsum, a triply toothed hind margin of the posterior pereon and anterior pleon segments, and the telson is unusually elongate.

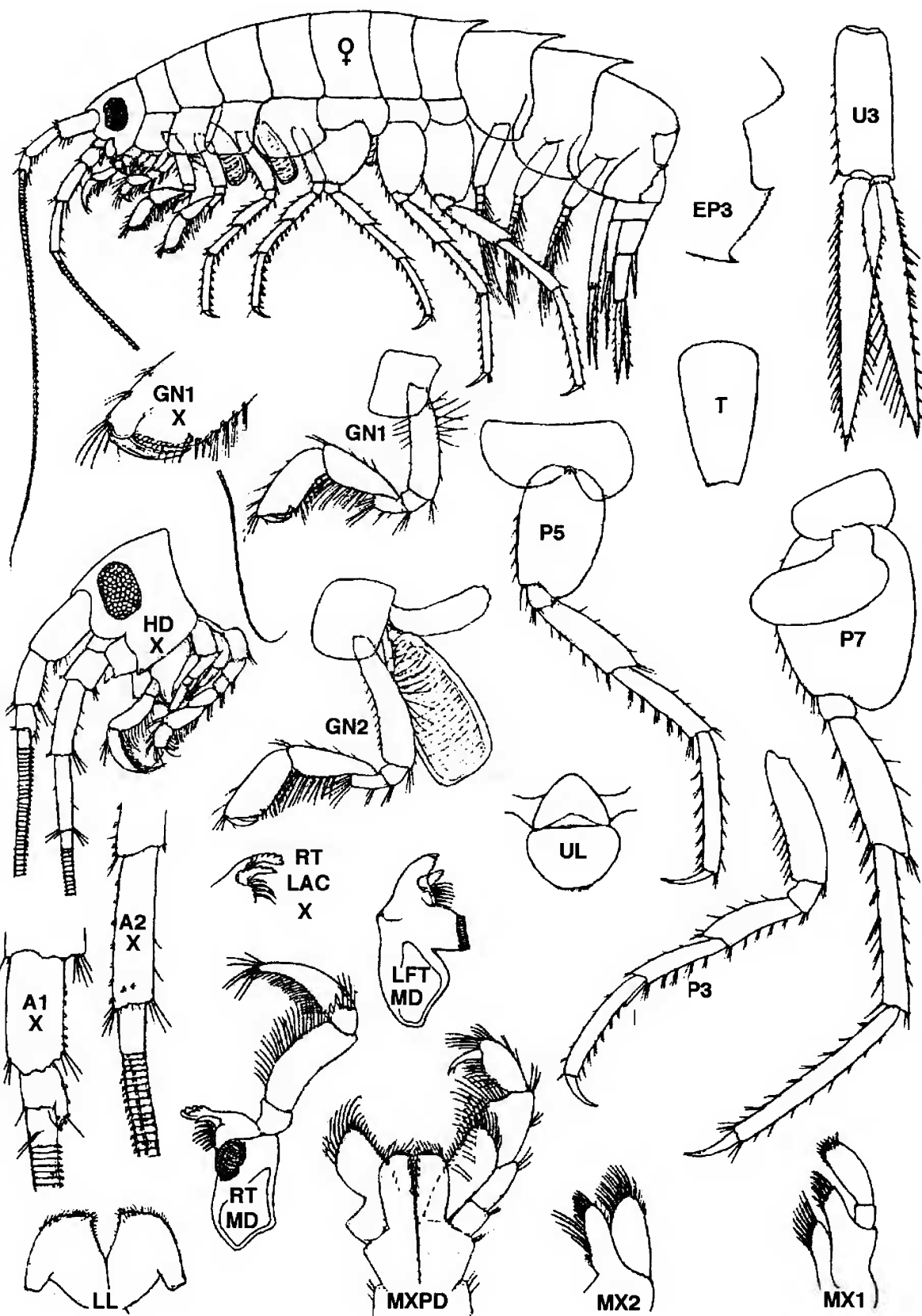


FIG. 30. *Halirages fulvocincta* (M. Sars). Arctic Norway. Female (19.0 mm) (afters Sars, 1895).

Laothoes Boeck

Laothoes Boeck, 1971: 202.—Stebbing, 1906: 286.—Gurjanova, 1951: 602.—Barnard, 1969a: 177.—Barnard & Karaman, 1991: 324.

Type species. *Laothoes meinerti* Boeck, 1971.

North Pacific species. *Laothoes polylovi* Gurjanova, 1946; *L. pacificus* Gurjanova, 1938 (= *L. macrocheir* Oldeveg, 1959, *vide* Barnard & Karaman, 1991).

Diagnosis. Body dorsally smooth. Head, rostrum short; inferior head lobe not produced. Eyes small, round. Antennae slender, elongate; flagella with numerous short segments lacking calceolae (both sexes). Antenna 1, peduncular segments short, segment 3 unproduced; flagellum not basally callynophorate; accessory flagellum lacking.

Lower lip lacking inner lobes. Mandibular palp normal, segment 3 little shorter than 2; left lacinia 5-dentate. Maxilla 1, inner plate with few (4-5) apical setae; outer plate with 9(?) tall apical spines; palp typically much shortened, 2-segmented. Maxilla 2, plates narrow, inner plate lacking facial setae. Maxilliped, outer plate very large, broad, inner margin with strong close-set spines; palp slender, short, little exceeding outer plate; inner plate relatively short, broad.

Coxae 1-4 medium, rounded below. Gnathopods slender, weakly subchelate, not sexually dimorphic; propods parallel-sided; palms short, nearly vertical; dactyls toothed behind; carpus variably shorter than propod, with shallow hind lobe.

Peraeopods 3 & 4 regular, stout, spinose; segment 5 < 4; dactyls strong. Peraeopods 5-7 homopodous, larger posteriorly; bases broad, hind lobes shallow; dactyls medium.

Pleon plates 2 & 3 smooth behind. Uropods 1 & 2, rami sublinear, outer ramus shortened. Uropod 3, rami broad-lanceolate, subequal; margins spinose.

Telson short, apex truncate or slightly emarginate.

Taxonomic commentary. *Laothoes* has specialized mouthparts and is otherwise relatively advanced (see phenogram, Fig. 39, p. 58).

Laothoes pacificus Gurjanova
(Fig. 31)

Laothoes pacificus Gurjanova, 1938: 309, fig. 25.—Gurjanova, 1951: 602, fig. 406.—Barnard & Karaman, 1991: 324.

Material Examined. None from study region.

Taxonomic and distributional commentary. The species has been recorded from Asiatic shores of the Bering and Chukchi Seas, at depths of less than 100 m, but not yet from the North American coast.

Laothoes polylovi Gurjanova

Laothoes polylovi Gurjanova, 1946: 287, fig. 20.—Gurjanova, 1951: 601, fig. 405.—Barnard & Karaman, 1991: 324.

Taxonomic and distributional commentary. *L. polylovi* differs from *L. pacificus* in its more slender gnathopods, less reduced palp of maxilla 1, and much smaller size at maturity (to 7.0 mm). The species is recorded from the Sea of Okhotsk and Bering Sea, at depths to 360 m.

Apherusa Walker

Apherusa Walker, 1891: 83.—Stebbing, 1906: 304.—Chevreux & Fage, 1925: 176.—Gurjanova, 1951: 626.—Barnard, 1969a: 174.—Barnard & Karaman, 1991: 304.

Type species. *Amphithoe jurinei* Milne-Edwards, 1830.

North Pacific regional species. *A. retovskii* Gurjanova; *A. glacialis* (Hansen, 1887); *Apherusa* sp. Park, 1961: 10—Austin, 1985: 589?

Diagnosis. Body smooth or weakly mucronate, especially on pleon segments 1 & 2. Head, rostrum small, short; inferior head lobe usually acutely produced. Eye roundish. Antennae slender. Antenna 1 distinctly the shorter; peduncular segments 2 & 3 short, lacking distal process; accessory flagellum lacking; calceoli usually lacking but present on antennae 1 & 2 in the type species (*vide* Chevreux & Fage, 1925).

Mouthparts little modified. Lower lip, inner lobes weakly developed. Mandibular palp segment 3 shorter than 2; lacinia 5-dentate; spine row medium. Maxilla 1, inner plate with 4-8 apical setae; outer plate with 11(9?) apical spines; palp normally 2-segmented. Maxilla 2, inner plate with submarginal and a few stout facial setae. Maxilliped regular, plates large; palp weakly unguiform.

Coxae 1-4 relatively small, shallow. Gnathopods weakly subchelate and subsimilar (both sexes), weakly to medium strongly sexually dimorphic; carpus shallow, not strongly shortened.

Peraeopods 3-7 regular, slender, segments 4 & 5 subequal in length; dactyls medium. Peraeopods 5-7 homopodous in form, regularly increasing in size posteriorly; bases relatively narrow, rounded behind, lower lobes small.

Pleon plates 2 & 3, hind corners acuminate, hind margins usually serrate or toothed, rarely smooth. Uropods 1 & 2, rami slender, linear; outer ramus of uropod 2 short. Uropod 3 large, rami lanceolate, margins spinose and variously (usually weakly) plumose-setose.

Telson entire, apex often acute. Coxal gills simple, not pleated.

Taxonomic and distributional commentary. About 20 species are recorded from the Mediterranean, North Atlantic and eastern Arctic regions, but few are recorded from

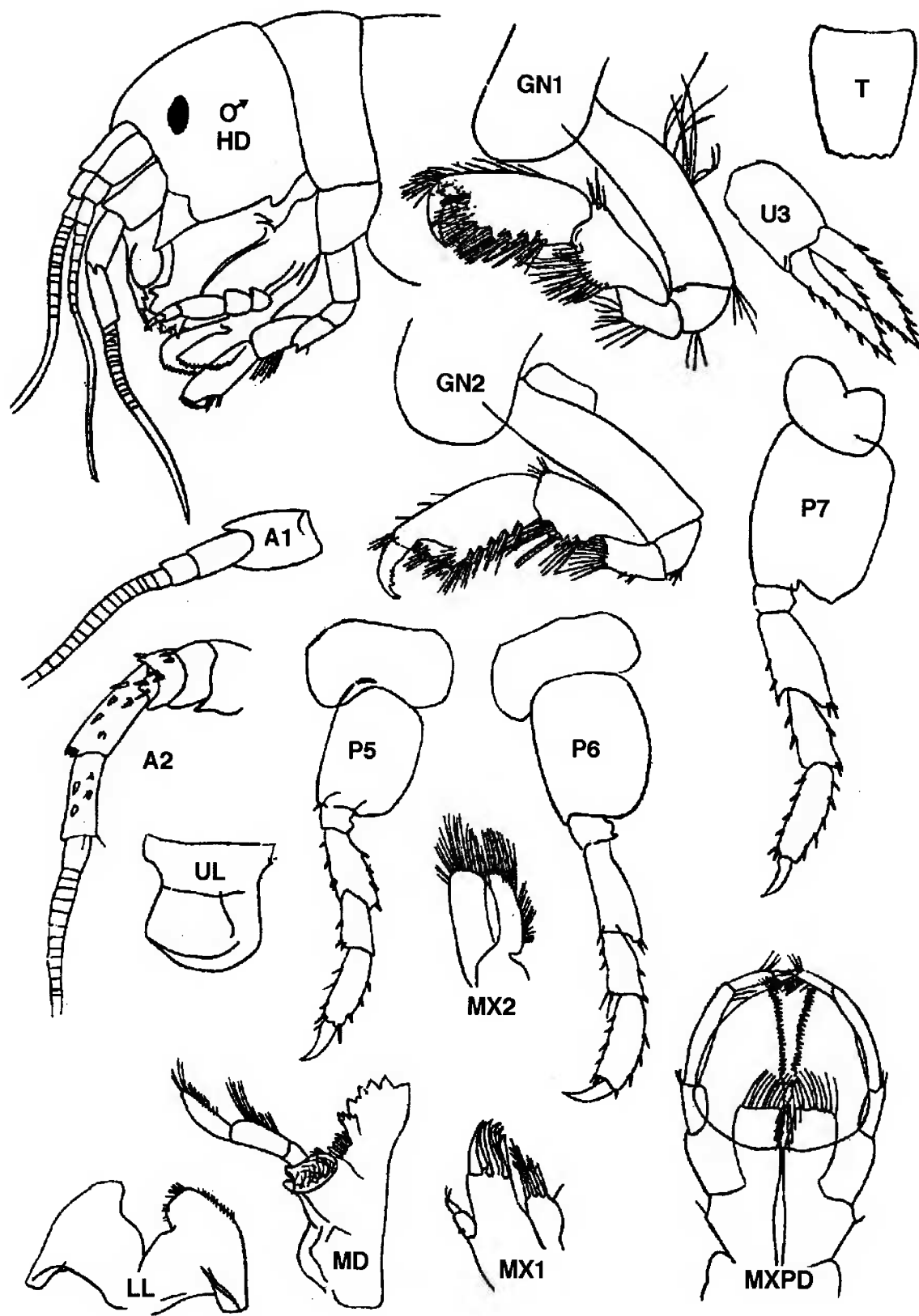


FIG. 31. *Laothoes pacificus* Gurjanova. Northeastern Sea of Japan. Male subadult (13.0 mm) (after Gurjanova, 1951).

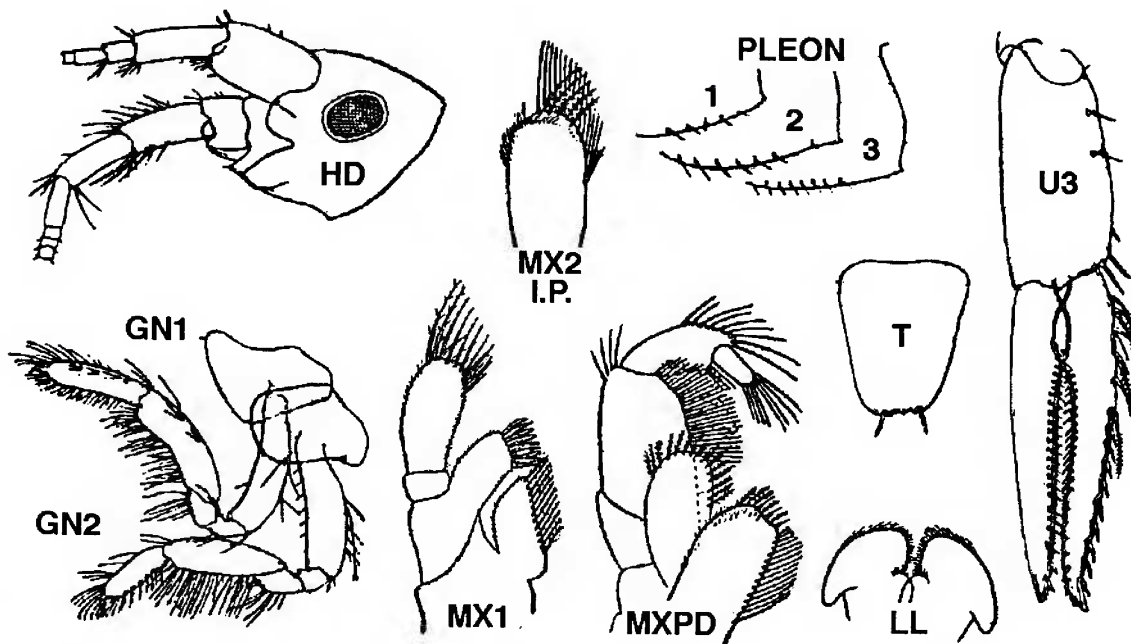


FIG. 32. *Apherusa glacialis* (Hansen). Female (to 20 mm). Arctic Seas (after Stephensen, 1931).

the western Nearctic or Siberian arctic and none authentically from the Bering Sea region. Of the 20 described species only 3 are characterized by a simple pleon plate 3 (not serrate or toothed behind), large marginally setose uropod 3, and truncate telson. The other 15 species, represented by *A. megalops* (fig. 33), show more advanced character states, including distinctly sexually dimorphic gnathopods, short spinose uropod 3 rami and apically acute telson. They are confined mainly to the Mediterranean and the boreal north-eastern (European) Atlantic coastal marine region.

This southern group actually possesses only a few features in common with the northern group, including a processiferous inferior head margin and partially developed inner lobes of the lower lip. These species appear to be a southern, warmer water counterpart of the genus *Paracalliopiella* of the boreal North Pacific region. Full review might lead to their separate generic recognition.

Apherusa glacialis (H.J. Hansen)
(Fig. 32)

Apherusa glacialis (Hansen, 1887) Shoemaker, 1920: 12.—Stephensen, 1931: 277, fig. 79.—Gurjanova, 1951: 632, fig. 432.—Shoemaker, 1955: 39.—Barnard & Karaman, 1991: 304.

Taxonomic and distributional commentary. This moderately large (to 20 mm) High Arctic species has been recorded sparsely from the Point Barrow region, from the under side of ice cakes, in shallow water (Shoemaker, 1955), and is marginally included here. The record of *Apherusa* sp. of Park (1961), repeated in Austin (1985), is problematical. It may represent a misidentification of *Oradarea longimana*

which it resembles superficially in gnathopods, uropod 3, and other character states.

Apherusa glacialis is a member of the primitive subgroup of calliopiids of which *A. jurinei* is the type, in which pleon side plate 3 is simple (not serrate or toothed behind), and the gnathopods are slender and the carpus elongate.

Apherusa megalops (Buchholz)
(Fig. 33)

Apherusa megalops (Buchholz, 1874) Shoemaker, 1930: 293, figs. 32-34.—Gurjanova, 1951: 631, fig. 430.—Barnard & Karaman, 1991: 304.

Taxonomic and distributional commentary. *A. megalops* typifies the largest generic subgroup having serrated pleon plate 3, gnathopods more or less medium strongly subchelate and sexually dimorphic, and telson variously modified (usually triangular and apically subacute).

This relatively small species is holarctic in distribution, including the Beaufort Sea, but has not yet been recorded from the Bering Sea region.

Oradarea Walker

Oradarea Walker, 1903: 40, 56.—Stebbing, 1906: 799.—Barnard, 1969a: 178 (part).—Shoemaker, 1930: 81.—Shaw, 1988: 942 (Table 1).—Barnard & Karaman, 1991: 330.
Leptamphopus G. O. Sars, Gurjanova, 1951: 612 (part).

Type species. *Oradarea walkeri* Shoemaker, 1930 (= *O. longimana* Walker, 1903, homonym).

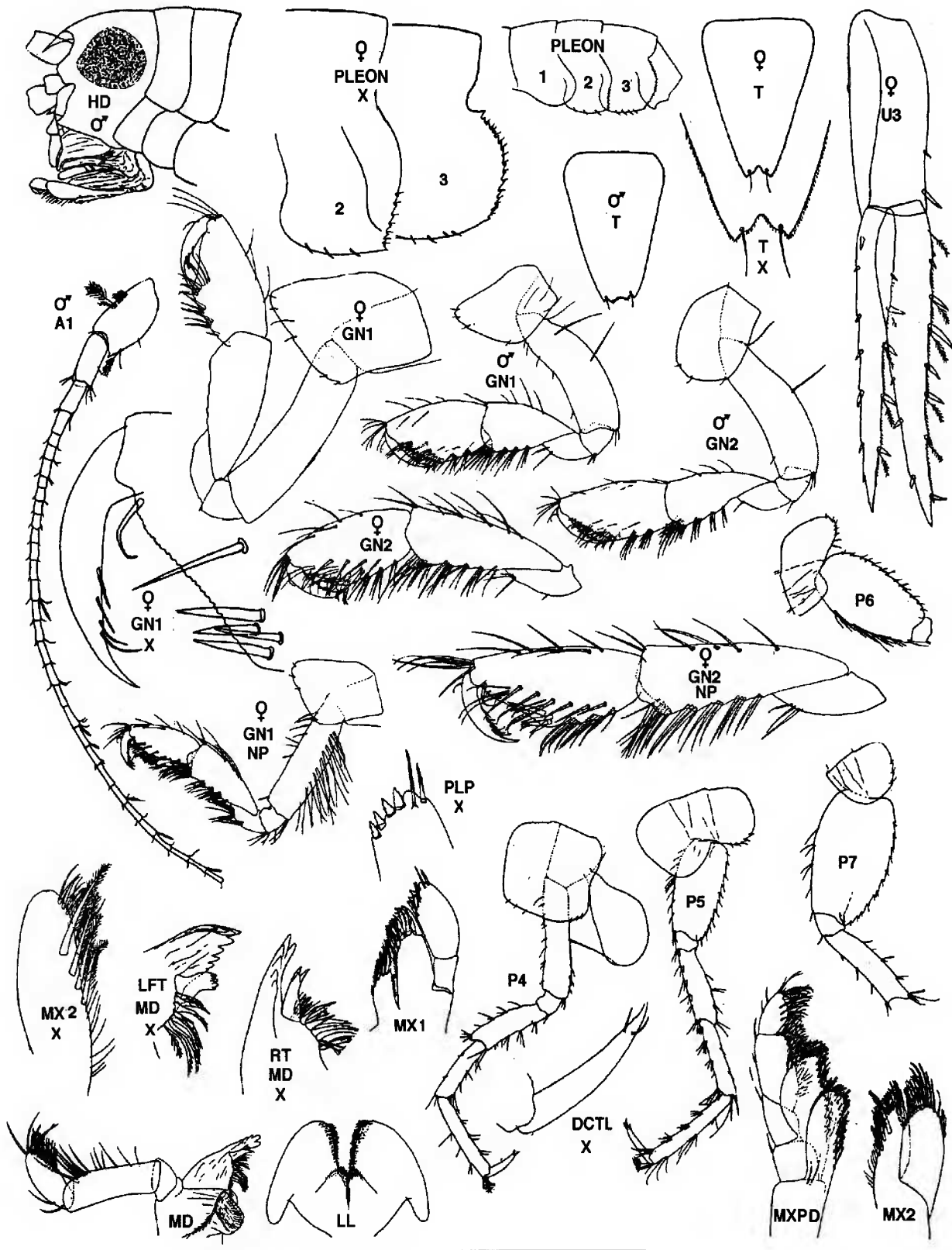


FIG. 33. *Apherusa megalops* (Buchholz). Gulf of St. Lawrence. Female (7.0 mm); male (5.0 mm). Legend NP - from original specimen of Deutsche Nordpolar Expedition (after Shoemaker, 1930).

Diagnosis. Body weakly mucronate on pleon and peraeon segment 7. Rostrum short. Eye small. Lower head process acute. Antennae slender, elongate. Antenna 1, peduncle short; accessory flagellum short, apex setose; flagellum weakly callynophorate, but lacking calceoli.

Mouthparts modified. Lower lip with distinct inner lobes. Mandibular palp segment 3 short, apex blunt; lacinia mobilis 5-dentate. Maxilla 1, inner plate multisetose. Maxilla 2, inner plate with facial setae. Maxilliped, inner plate broad; outer plate normal; palp, dactyl short.

Coxae 1-4 regular, deeper than broad. Gnathopods weakly subchelate, slender, very unequal. Gnathopod 2 much the longer, carpus and propod elongate (both sexes).

Peraeopods regular, slender, dactyls small. Peraeopods 5-7 elongate, homopodous; dactyls short.

Pleon plates 2 & 3 lacking facial spines, hind corners not acuminate. Uropods 1 & 2, rami slender, elongate, weakly spinose, outer ramus much the shorter. Uropod 3, rami very unequal (inner longer), margins spinose only.

Telson short, length slightly greater than width, apex very weakly notched.

Coxal gills plate-like, not pleated.

Taxonomic commentary. Shoemaker (1930) submerged *Leptamphopus longimanus* within Walker's genus *Oradarea*, a decision not accepted by Gurjanova (1951). Barnard & Karaman (1991) regard the species *walkeri*, newly named by Shoemaker (*loc. cit.*), as the type of the genus *Oradarea*. Paradoxically, of the 14 species currently recognized in the genus *Oradarea*, all but the type species are antarctic, antiboreal, or deep-sea tropical in distribution.

Oradarea longimana (Boeck)
(Fig. 34)

Amphithopsis longimana Boeck, 1871: 200.

Oradarea longimana (Boeck, 1971) Stebbing, 1906: 799.—Shoemaker, 1930: 298, figs. 35-37.—Austin, 1985: 589.—Staude, 1987: 378.—Shaw, 1989: 1889.—Barnard & Karaman, 1991: 330.

Leptamphopus longimanus (Boeck, 1871) Gurjanova, 1951: 614, fig. 416.

?*Leptamphopus novaezealandiae* (Thomson) Nagata, 1965: 174.—Ishimaru, 1994: 44.

Material examined. Specimens detailed by Shaw (1989) from Endeavour Segment, Juan de Fuca Ridge vent site, 2200 m, ~200 km west of Vancouver Island, B. C. This species has also been recorded from San Juan Channel (Staude, pers. comm.).

Taxonomic and distributional commentary. *Oradarea longimana* is panboreal at sublittoral to abyssal depths in the North Atlantic and North Pacific Oceans. The species is believed to be an obligate scavenger or commensal with larger crustaceans, on bottoms of mixed mud, sand, and shell.

Bouvierella Chevreux

Bouvierella Chevreux, 1900: 70.—Barnard, 1969a: 175.—Barnard, 1969b: 95.—Shaw, 1988: 939.—Barnard & Karaman, 1991: 311.

Diagnosis. Body smooth, without dorsal processes or carina. Rostrum short; anterior head lobe subacute. Pigmented eyes lacking. Antenna 1 slightly longer than 2. Antennal peduncles short; accessory flagellum very short or lacking; callynophore and calceoli lacking.

Mouthparts basic. Upper lip slightly notched. Lower lip simple. Mandible, palp normal, left lacinia 7-dentate. Maxilla 1 normal, inner plate with numerous marginal setae. Maxilla 2, inner facial setae numerous, regular. Maxilliped, inner plate short; outer plate broadened.

Coxae 1-4 large, deep. Gnathopods 1 & 2 slender, weakly subchelate, sexually alike; carpus of gnathopod 2 elongate.

Peraeopods 3-7 regular, weakly subchelate, dactyls short. Peraeopods 5-7 closely homopodous; bases broad.

Pleon large; plates 2 & 3, hind corners obtuse; pleopods powerful. Uropods 1 & 2, rami sublinear, serially spinose, with weak apical spines, outer ramus shorter. Uropod 3, rami narrowly lanceolate, margins spinose. Telson plate-like, apex with V-cleft.

Coxal gills plate-like, simple, on peraeopods 2-7. Brood plates moderately broad to narrow.

Taxonomic commentary. The genus *Bouvierella* is closest to *Oradarea*, and other "long wristed" leptamphopid genera of calliopiids, but differs in its weakly prehensible peraeopods. The species from Japanese waters, identified by Nagata (1965) and Inaba (1988) as *O. novaezealandiae* (Thomson, 1879), appears synonymous with *O. longimana* (Boeck).

Bouvierella carcinophila (Chevreux)
(Fig. 35)

Bouvierella carcinophila Chevreux, 1889.—Shaw, 1988: 939, figs. 1, 2.—Barnard & Karaman, 1991: 311.

Leptamphopus paripes Stephensen, 1931: 280, fig. 80.

Material examined. Material of P. Shaw (*loc. cit.*) from head and mouth of Alice Arm, Vancouver I., in shrimp and crab pots set at 95 m (possibly associated with the spider crab *Chionoecetes* sp.).

Taxonomic and distributional commentary. *Bouvierella carcinophila* is a small to medium, slender species known from sublittoral to abyssal depths in the North Atlantic and North Pacific regions. In the North American Pacific region, the species has been recorded by Shaw (1988) from Olga Bay, Alaska, to Alice Arm, B. C., from crab pots set at depths of ~75-180 m. Shaw (*loc. cit.*) has synonymized this species with *Leptamphopus paripes* Stephensen (1931), originally described from Danish Ingolf material off E.

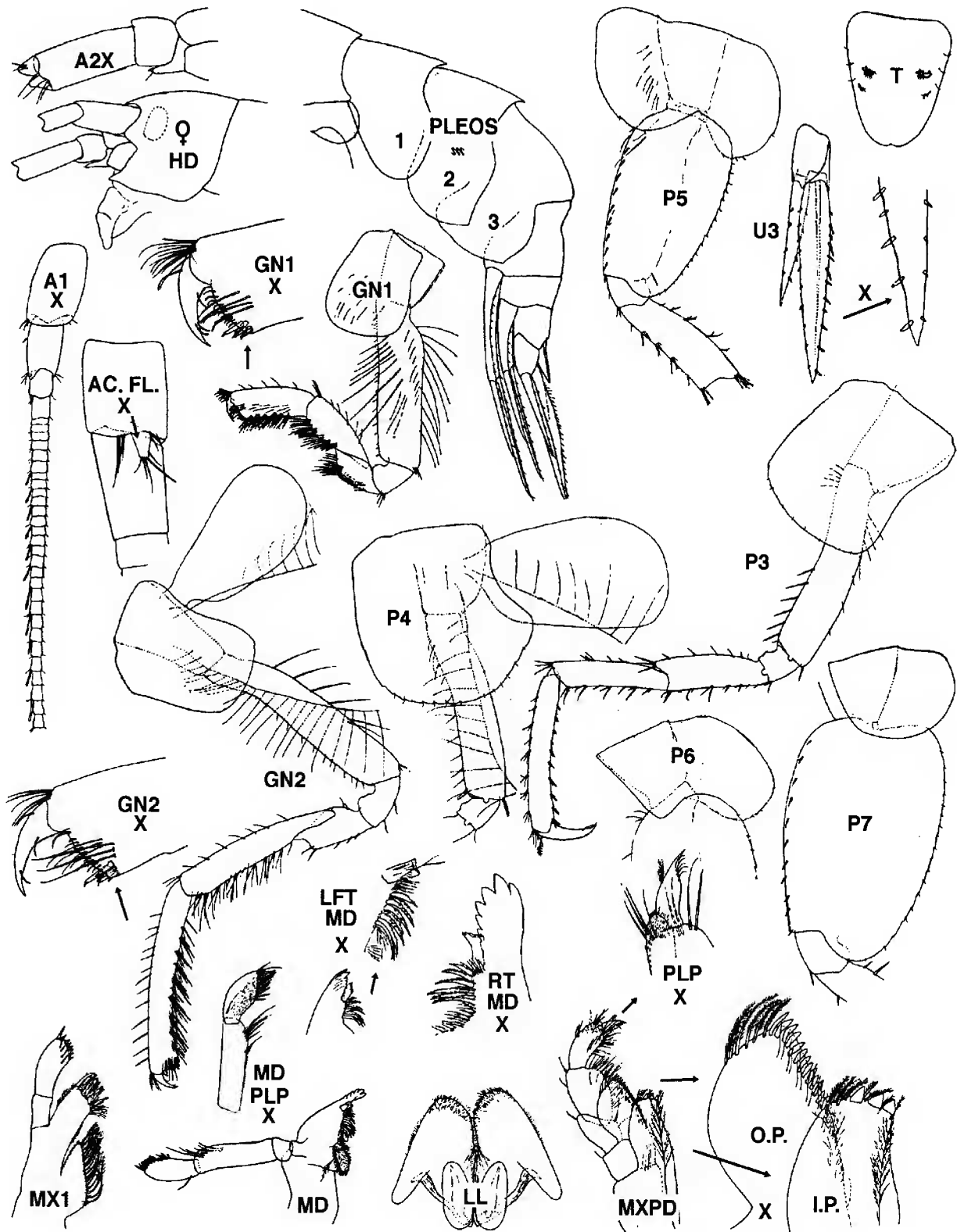


FIG. 34. *Oradarea longimana* (Boeck). Gulf of St. Lawrence. Female (11.0 mm) (after Shoemaker, 1930)

Greenland, a decision tentatively accepted here. Vader (1983) has discussed the significance of prehensile pereopods in gammaridean amphipods, including those associated

with decapod crustaceans. *B. carcinophilus* appears to be associated with decapod crabs, possibly as a scavenging commensal.

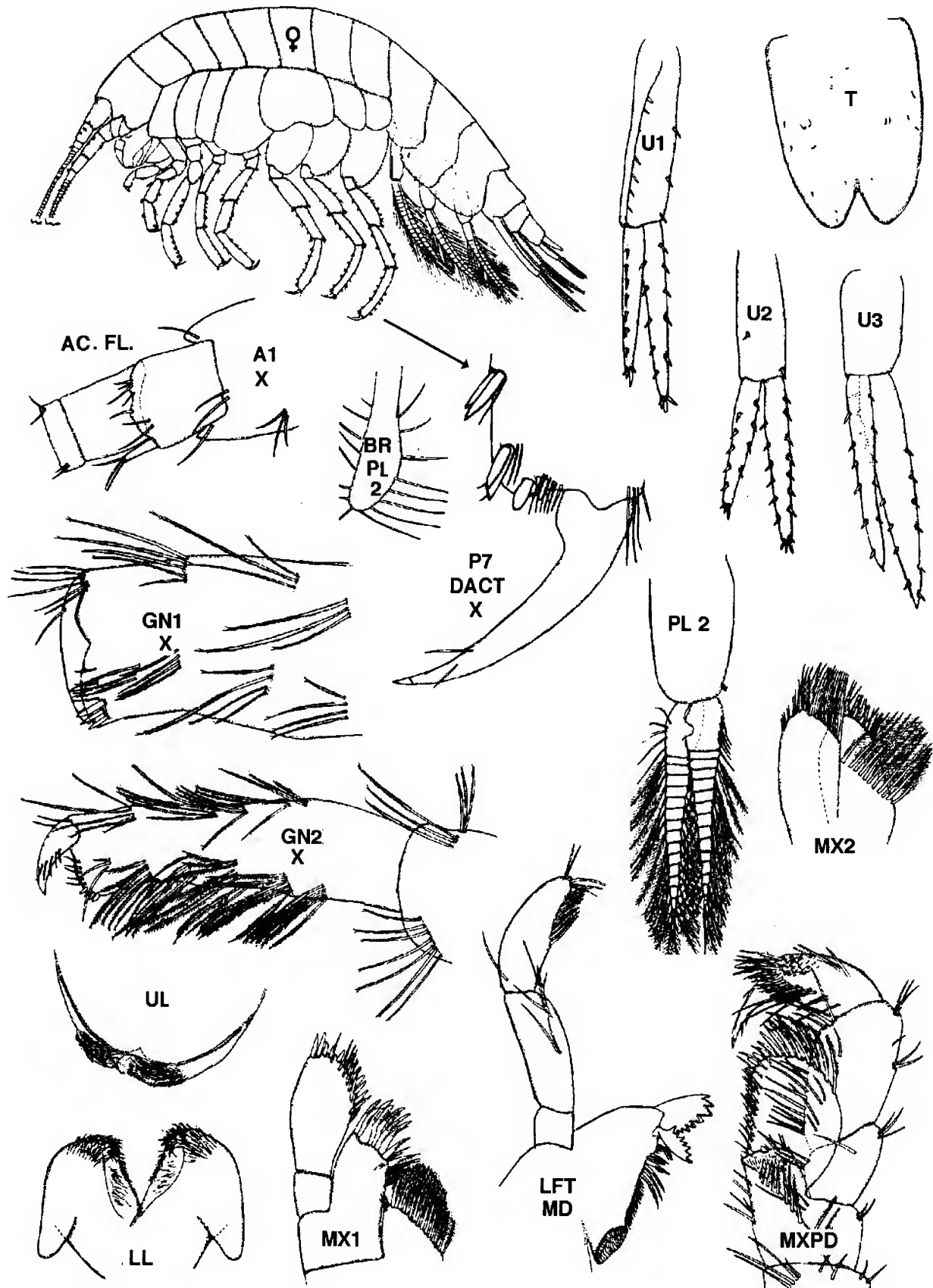


FIG. 35. *Bouvierella carcinophila* (Chevreux). Alice Arm, B. C. Female (7.3 mm) (after Shaw, 1988).

Weyprechtia Stuxberg

Weyprechtia Stuxberg, 1880: 27.—Stebbing, 1906: 380.—Gurjanova, 1951: 735.—Barnard & Barnard, 1983: 595, figs. 39, 40.—Barnard & Karaman, 1991: 26.

Type species. *Amathilla heugleni* Buchholz, 1874.

North Pacific regional species. *Weyprechtia heugleni* (Buchholz, 1874); *W. pinguis* (Kroyer, 1838).

Diagnosis. Body dorsally smooth. Head, rostrum short; inferior antennal sinus shallow, inferior head lobe not produced. Eye medium. Antennae medium, slender, 2 the longer, calceolate in male. Antenna 1, peduncle 3 not distally produced; accessory flagellum well developed (3+ segmented).

Mouthparts basic. Upper lip deep, rounded below, epistome produced. Lower lip lacking inner lobes (present?). Mandibular palp, segment 3 larger than 2. Maxilla 1, inner plate strongly setose; outer plate with 11 apical spines; palp strong, 2-segmented. Maxilla 2, inner plate with strong row of facial setae. Maxilliped plates and palp regular.

Coxae 1-4 medium, deeper than long, lower hind margin serrate. Gnathopods weakly subchelate, subsimilar, not sexually dimorphic; propod, palm oblique; posterodistal spines few; dactyls smooth behind; carpus shallow, usually longer than propod.

Peraeopods 3 & 4 regular, segment 5 <4; dactyls medium. Peraeopods 5-7 regularly homopodous; bases medium broad, hind lobes distinct; dactyls moderately long.

Pleon plate 3 singly toothed behind, lower corner acute. Uropods 1 & 2, rami lanceolate, margins sparsely spinose; outer ramus shortened. Uropod 3, rami lanceolate, subequal, margins spinose.

Telson medium, subtruncate or weakly notched apically. Coxal gills large, not pleated. Brood plates broad.

Taxonomic and distributional commentary. The genus was transferred from Gammaridae to Calliopiidae by Bousfield (1977) although still retained within the gammaroidean family complex by Barnard & Barnard (1983). The overall dorsally smooth body, weakly rostrate head, weakly subchelate, not sexually dimorphic gnathopods, homopodous, posterolobate peraeopods, lanceolate uropods, plate-like telson, and pontogeniid-like calceolus are charac-

ter states that are basically eusiroidean (see Bousfield & Shih, 1994). The two known species are described as arctic-boreal littoral marine endemics (Barnard & Karaman, 1991). They are among the most primitive members of family Calliopiidae. The genus *Weyprechtia* is isolated phylogenetically from all other genera but *Halirages* (Fig. 39, p. 58).

Weyprechtia pinguis (Kroyer)
(Fig. 36)

Weyprechtia pinguis (Kroyer, 1838) Gurjanova, 1951: 737, fig. 509.—Shoemaker, 1955: 48.—Just, 1970: 28, figs. 13-15.—Barnard & Barnard, 1983: 596.—Bousfield & Shih, 1994, fig. 9 (part).

Material Examined. None from the study region.

Taxonomic and distributional commentary. This medium large species (to 29 mm) occurs mainly in the North Atlantic and eastern Nearctic regions, but has been recorded from Pt. Barrow, Alaska (Shoemaker, 1955), and sparsely from the Sea of Okhotsk (Gurjanova, 1951).

Weyprechtia heugleni (Buchholz)
(Figs. 37, 38)

Weyprechtia heugleni (Buchholz, 1874) Derzhavin, 1930: 328.—Stebbing, 1894: 41, pl. 7.—Gurjanova, 1951: 735, fig. 508.—Shoemaker, 1955: 49.—Barnard & Barnard 1983: 596, figs. 39C, 40 A.

Material examined. None from the study region.

Taxonomic and distributional commentary. This very large species (to 52 mm) is common at Pt. Barrow, Alaska, and widely distributed in the Chukchi Sea and northern part of the Bering Sea region (Gurjanova, 1951).

Weyprechtia heugleni is sufficiently unlike the type species, *W. pinguis*, that the former could well merit generic distinction of its own. Especially significant are the reported inner lobes of its lower lip, strong development of the mandibular palp, the epimerid-like development of coxa 4, and the broadly lanceolate form of the uropod rami that lack apical spines. Lack of regional study material prevents further analysis here.

KEY TO NORTH PACIFIC SPECIES OF WEYPRECHTIA

- 1. Coxal plate 4 normal, not produced laterally; antennae 1 & 2 subequal; uropod 3, rami narrowly lanceolate *W. pinguis* (p. 54)
- Coxa 4 produced laterally; antenna 2 elongate; uropod 3, rami broad *W. heugleni* (p. 54)

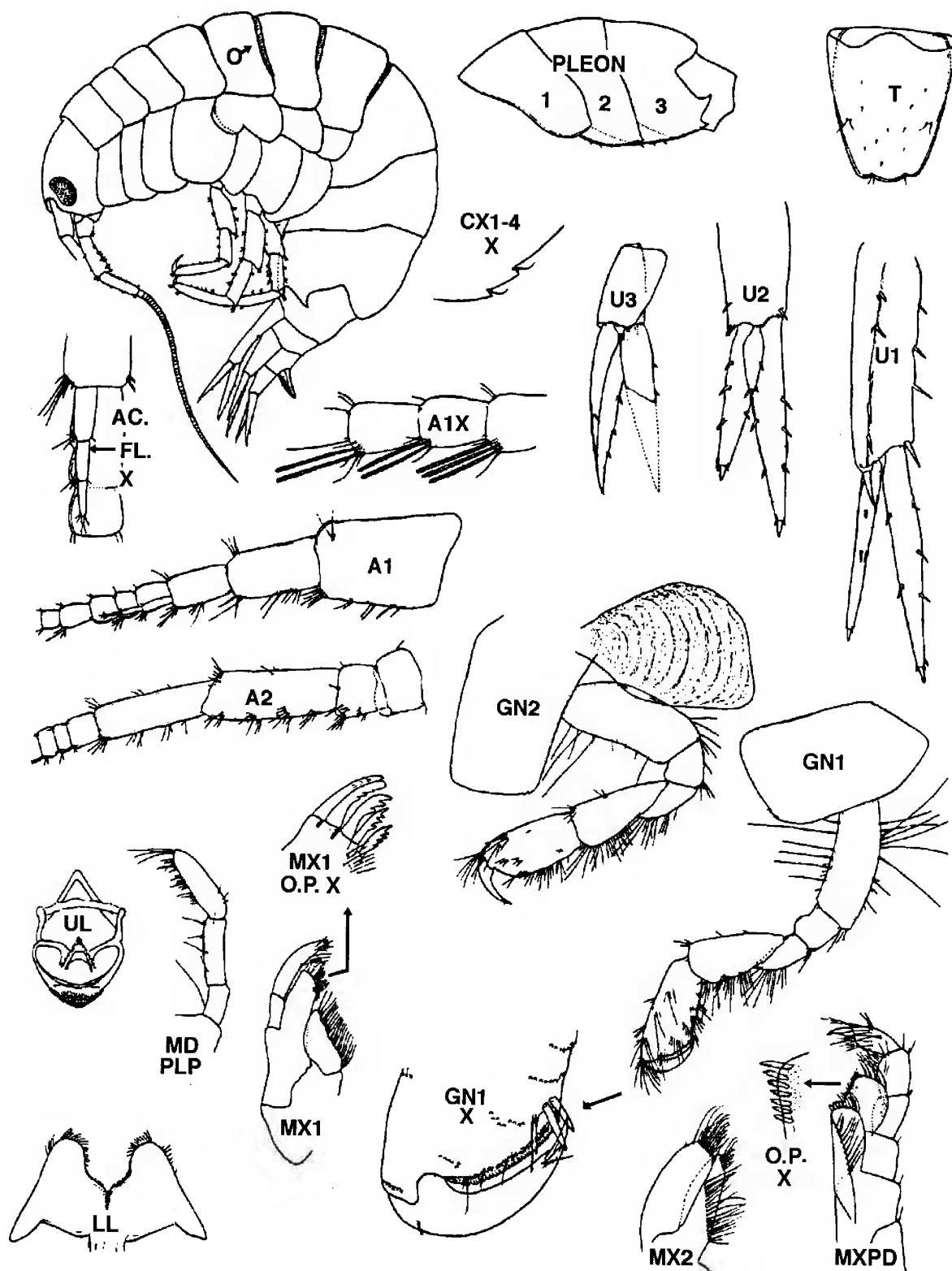


FIG. 36. *Weyprechtia pinguis* (Kroyer). Danish Ingolf Stn 49, off Greenland. Male (13-15 mm) (after Just, 1970).

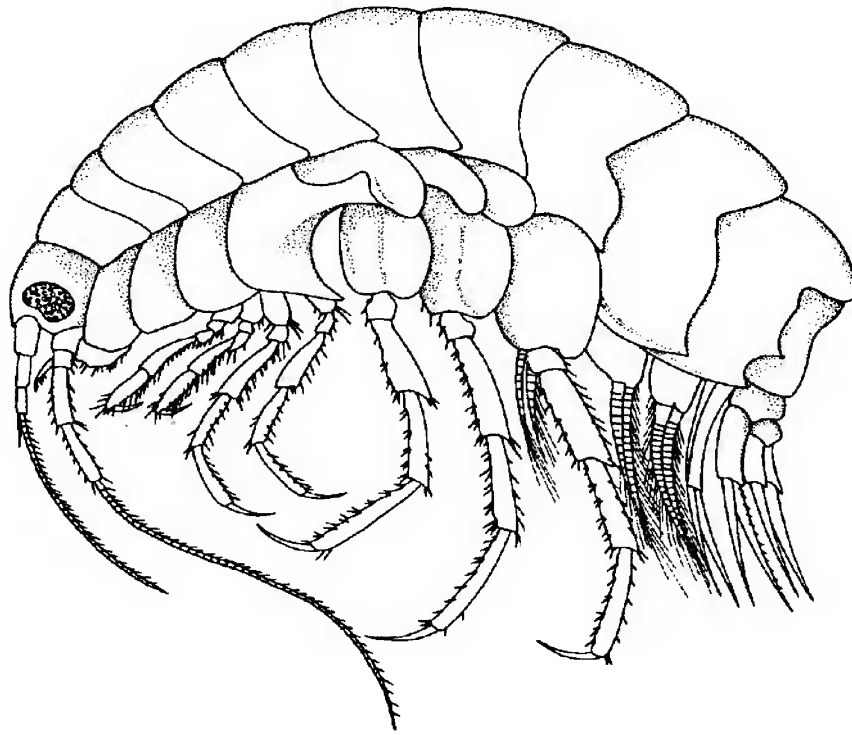


FIG. 37. *Weyprechtia heugleni* (Buchholz) Arctic Ocean, littoral. Female (30 mm)
(after Barnard & Barnard, 1983)

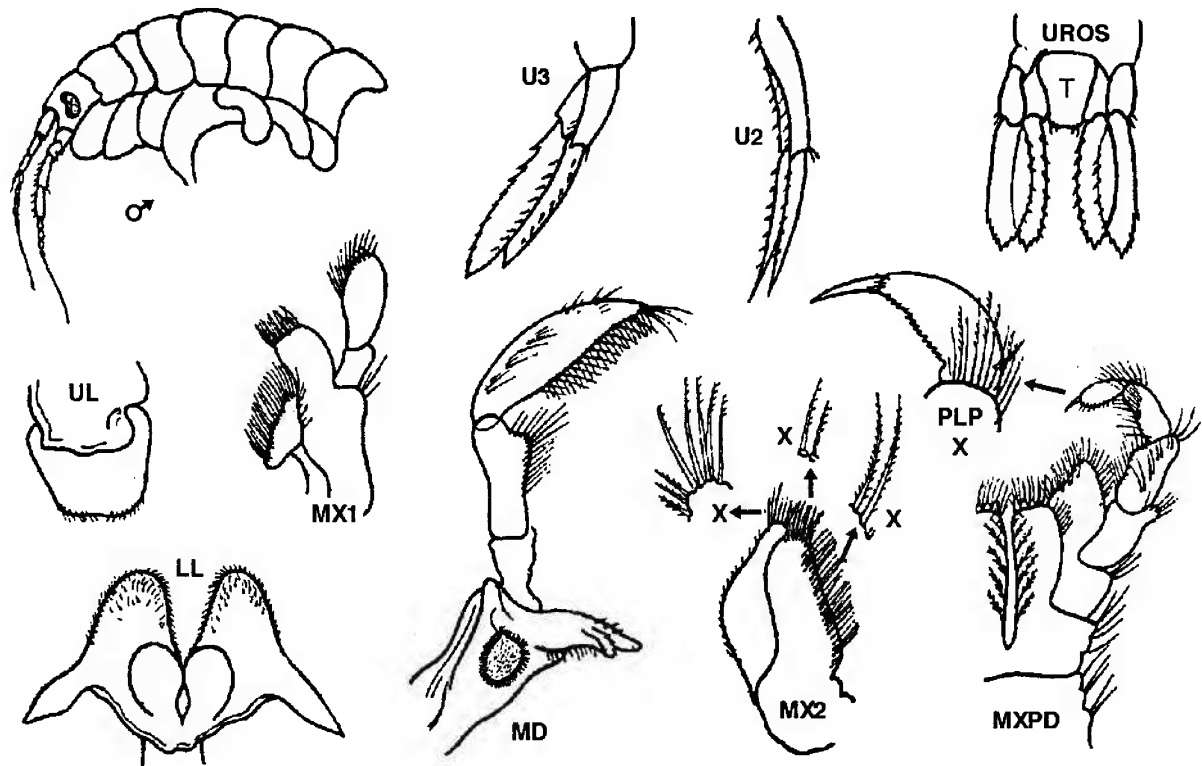


FIG. 38. *Weyprechtia heugleni* (Buchholz). Male (52 mm). Arctic Ocean to Bering Sea
(after Gurjanova, 1951).

TABLE I. CHARACTERS AND CHARACTER STATES: GENERA OF CALLIOPIIDAE

CHARACTER	CHARACTER STATE VALUE		
	Pleomorphic 0	Intermediate 1	Apomorphic 2
1. Antennal calceoli	present, both sexes	present males only	lacking both sexes
2. Antenna 1, accessory flagellum	present, 3+ segmented	present, minute	lacking
3. Antenna 1, segment 3 postero-distal process	lacking	present, small	present, well developed
4. Lower lip, inner lobes	lacking	trace	partly developed
5. Mandibular palp ratio: segment 3/ segment 2	>1	~1	<1
6. Maxilla 1, number of inner plate setae	10+	7-9	4-6
7. Maxilla 2, inner plate, row of facial setae	present, strong (5+)	present, few (1-4)	lacking, or marginal only
8. Maxilliped, outer plate	Normal		much enlarged or short, broad
9. Gnathopods 1 & 2 sexual dimorphism	lacking	slight	distinct
10. Gnathopods 1 & 2, form of propod	slender		short, deep
11. Gnathopod 2, form of carpus	slender not lobate		short, lobate below
12. Peraeopods 3-7 dactyls	short or weak		elongate or strong
13. Pleon plate 3, hind margin	smooth normal	single stout tooth	strongly serrate
14. Uropods 1 & 2, rami	lanceolate, apical spines lacking		linear, apical spines strong
15. Uropod 3, rami	subequal margins setose		unequal, margins spinose
16. Telson, form	elongate, apex notched	shorter, apex subtruncate	short, apex subacute

TAXONOMIC DISCUSSION

In this systematic study of calliopiid amphipods, as the family is diagnosed herein (p. 4), we have examined survey material of 13 species in 5 genera from the North American Pacific coastal region, from the Bering Sea to central California. An additional 13 species in 6 genera, occurring in

Arctic waters immediately adjacent to the Bering Sea, or in the Asiatic North Pacific regions, are included in the following taxonomic and biogeographical analyses. These numbers represent about one-third of the species recorded to date from the Northern Hemisphere, and about one-fifth of the total marine calliopiid fauna world-wide.

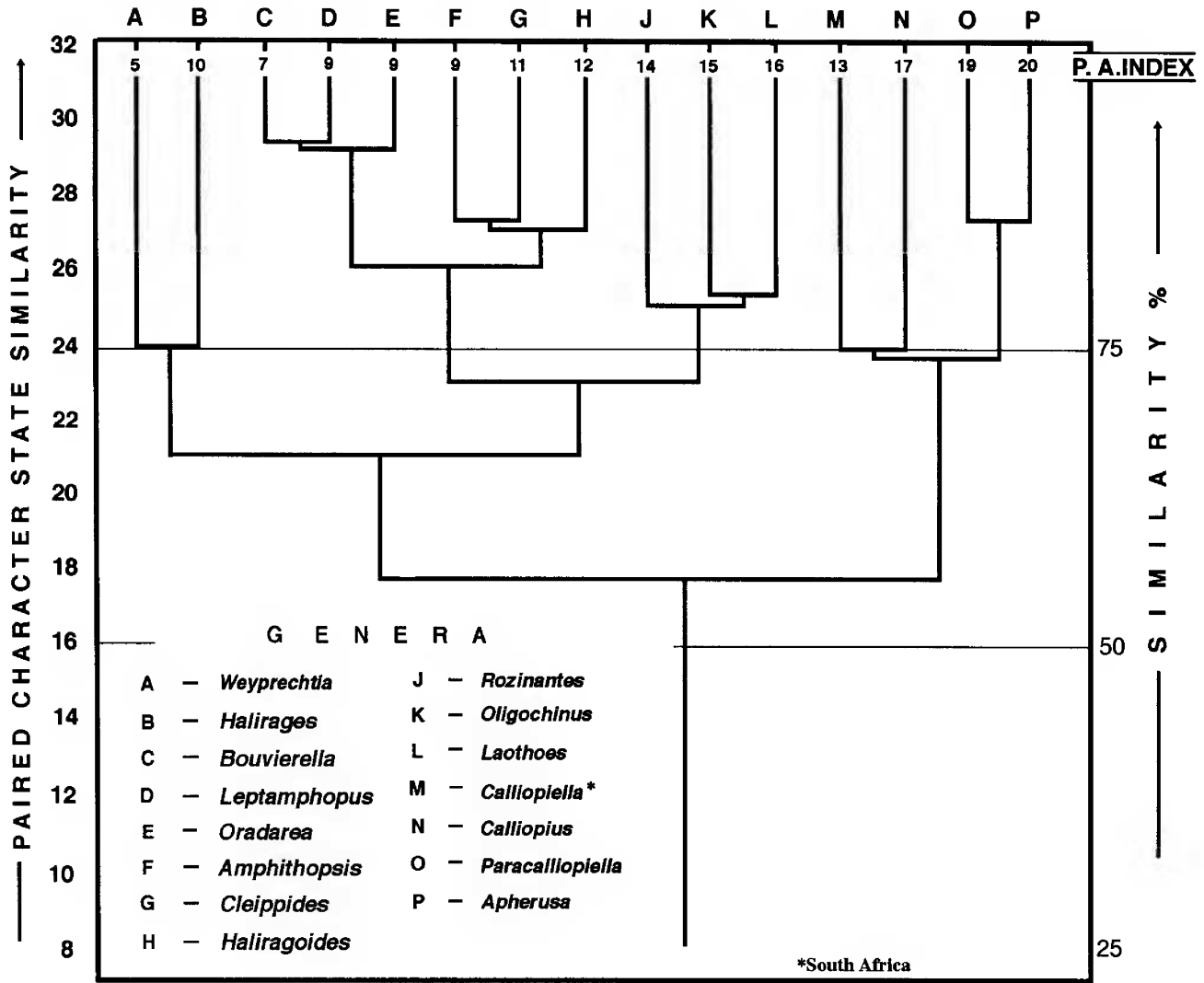


FIG. 39. PHENOGRAM: MAINLY HOLARCTIC GENERA OF CALLIOPIDAE.

Morphological similarities as a basis for phyletic relationships.

Despite the relatively limited scope of the material at hand, the pertinent morphological and distributional data assembled here may be analyzed, on a numerical basis, for possible broader phyletic and biogeographical significance. A modification of the phenetic UPGMA (cluster analysis) system of Sneath and Sokal (1973) has been employed previously in similar regional faunistic studies (e.g., Jarrett & Bousfield, 1994; Bousfield & Hendrycks, 1995) and is utilized here. In this system, the character states are ordered on a presumed phyletic basis. Thus, the plesiomorphic condition (state) of a character is given a numerical value of 0, the advanced or apomorphic state a value of 2, and an intermediate condition, where applicable, a value of 1. By totalling the numerical values for individual character states, an overall criterion of morphological similarity termed the Plesio-Apomorphic (P.-A.) Index is obtained. Low P.-A. values signify phyletically primitive, and high numbers relatively advanced, taxa.

Within a restricted definition of the family Calliopiidae

(p. 4), analysis of morphological similarities of genera, mainly of the Northern Hemisphere, is based on 16 characters and corresponding 32 paired character state extremes (Table I, p. 57). The characters selected include a mixture of conspicuous body features, usually embodied in descriptions and figures of the previous literature, as well as more cryptic, but possibly more phyletically significant features, especially those of the mouthparts.

Similarities in the ordered character states of mostly northern calliopiid genera are phenetically analyzed (Fig. 39, above). Phyletic relationships are suggested by the four main groupings in which genera are relatively closely similar (at and above 75% similarity level). These are: (1) a primitive *Weyprechtia-Halirages* subgroup on the extreme left (P.-A. Indices of 5-10); (2) a primitively intermediate *Bouvierella-Haliragoides* subgroup of six genera in the centre left (P. A. Indices of 7-12), and (3) an intermediate but relatively advanced *Oligochinus* cluster in the centre right (P.-A. values of 14-16); and (4) a cluster of four advanced genera (including *Calliopus*) on the right (P. A. Indices of 13-20).

With respect to (1), character states are almost uniformly plesiomorphic, including calceolate antennae, basic mouthparts and strongly toothed pleon plates. These are large species, confined to arctic littoral and sublittoral substrata.

Within cluster (2) are two subclusters, *viz.*, a relatively primitive *Leptamphopus* complex that includes *Bouvierella* and *Oradarea*. These deep-water species are characterized strikingly by elongate, weakly subchelate gnathopods with slender wrists, by short peraeopod dactyls, apically notched telson, and basic mouthparts. They are linked at the 80% similarity level with the more advanced sublittoral *Amphithopsis-Haliragoides* complex, mainly of the North Atlantic region, in which the mouthparts are more specialized, the gnathopod wrists shorter, and the telson plate-like.

The intermediate cluster (3) links distantly, and perhaps unnaturally, the eastern North Pacific littoral genus *Oligochinus*, with two arctic and subarctic sublittoral genera, *Rozinante* and *Laothoes*.

Cluster (4) encompasses the holarctic genus *Calliopius* and the South African genus *Calliopiella*. However, their advanced character state similarities (e. g., powerful gnathopods in both sexes) are probably homoplasious. More closely, and probably more naturally, linked are the two most advanced genera, the littoral North Pacific *Paracalliopiella* and its mainly Arctic and North Atlantic counterpart *Apherusa*. Their more apomorphic character states, especially of mouthparts and uropods, plate-like telson, and sexually dimorphic gnathopods, are associated with the more benthic-epibenthic life styles and more southerly distributions of holarctic littoral species.

Relationships between species within the genus *Calliopius* are suggested by the phenetic analysis of Fig. 40 (p. 60). In the phenogram, three major subgroups cluster at or above the 75% similarity level: (1) to the left, a primitive North Pacific *behringi-columbianus* pair (P.-A. values of 8-9); (2) in the centre left, an intermediate North Pacific *carinatus-pacificus* species pair (P. A. values of 14-18); and (3) to the right, an advanced North Atlantic *laeviusculus-rathkii* complex of four species (P.-A.Indices of 16-22).

With respect to the species pair of (1), character states are mainly plesiomorphic and include multi-segmented antennal flagella, minute antennal calceoli that occur in three or more posterior (inner) facial rows; maxilla 2, inner plate with weak facial seta(e); coxa 4 very broad; basis of peraeopod 7 broadly lobate, and the outer ramus of uropod 3 broadly lanceolate.

Within intermediate group (2), species have relatively few but large antennal flagellar segments; antennal calceoli are larger and concentrate along segmental posterior margins; maxilla 2, inner plate with single stout facial seta; coxa 4 is relatively narrow and rounded below; the basis of peraeopod 7 is more narrowly lobate, and the rami of uropod 3 more narrowly lanceolate.

Within advanced subgroup (3), the clustering tends to support the species distinctiveness of the *laeviusculus-crenulatus* taxonomic pairing, and continued recognition of

C. rathkii (Zaddach) that G. O. Sars (1895) had so ably demonstrated in his monographic study of the Norwegian amphipod fauna a century ago.

The phenetic analysis further indicates that the most primitive subgroup is sufficiently distinctive (at ~50% level of similarity) to warrant subgeneric recognition. However, *Calliopius sablensis*, the most primitive member of the advanced Atlantic subgroup, exhibits some character states (e.g., small antennal peduncular process, broad coxae 3 & 4) variously in common with Pacific species, and its single record of occurrence is from the western North Atlantic. Thus, in comparing the plesio-apomorphic ratings of component species, the most primitive species occur only in the North Pacific and the most advanced only in the eastern North Atlantic. Thus, the North Pacific appears to be a plausible centre of origin and evolution of the genus *Calliopius*. Ancestral forms may have penetrated the North Atlantic secondarily, via an eastward arctic pathway.

Probable phyletic relationships of ten described species within the North Pacific genus *Paracalliopiella* are suggested by the closeness of morphological similarities shown in Fig. 41 (p. 60). The analysis employed a slightly different and more numerous suite of characters and corresponding character states. These included the degree of dorsal carination of peraeon and pleon; number of flagellar segments of antenna 1; size of the accessory flagellum of antenna 1; and degree of setation of the rami of uropod 3.

Four major subgroupings at and above 75% similarity can be recognized: (1) on the left, a very primitive, closely related *bungei-shoemakeri-haliragoides* trio (P.-A. Index of 7-11); (2) on the centre left, an intermediate pair of *beringensis-tzvetkovae* (P.-A. Index of 14-17); (3) on the centre right, a less closely similar intermediate trio of *pacifica-slatteryi-kudrjaschovi* (P. A. Index of 18-20); and (4) on the right, a very advanced *litoralis-pratti* species pair (P.-A. Index of 28-31).

Subgroup (1) consists of relatively large species having strongly carinated dorsum, elongate antennae, elongate carpus and propods of gnathopods 1 & 2, elongate and setose inner ramus of uropod 3, and other plesiomorphic character states.

Subgroup (2) retains mainly plesiomorphic character states, including elongate gnathopod carpus (female), gnathopod 2 stronger than 1 (male), and telson elongate. More advanced characters states include weakly developed inner lobes of the lower lip, very weakly carinate pleon and smaller size at maturity.

With respect to (3), the pleon and posterior peraeon remain slightly carinated, and the antennal flagella and uropod 3 rami are elongate. However, more apomorphic character states include a medium to short carpus in gnathopod 2 (female); gnathopod 2 (male) slightly more strongly subchelate than gnathopod 1; and uropod 3 margins are spinose or, if setose, very weakly so.

Subgroup (4) embraces two small intertidal species having mostly apomorphic character states. These include a

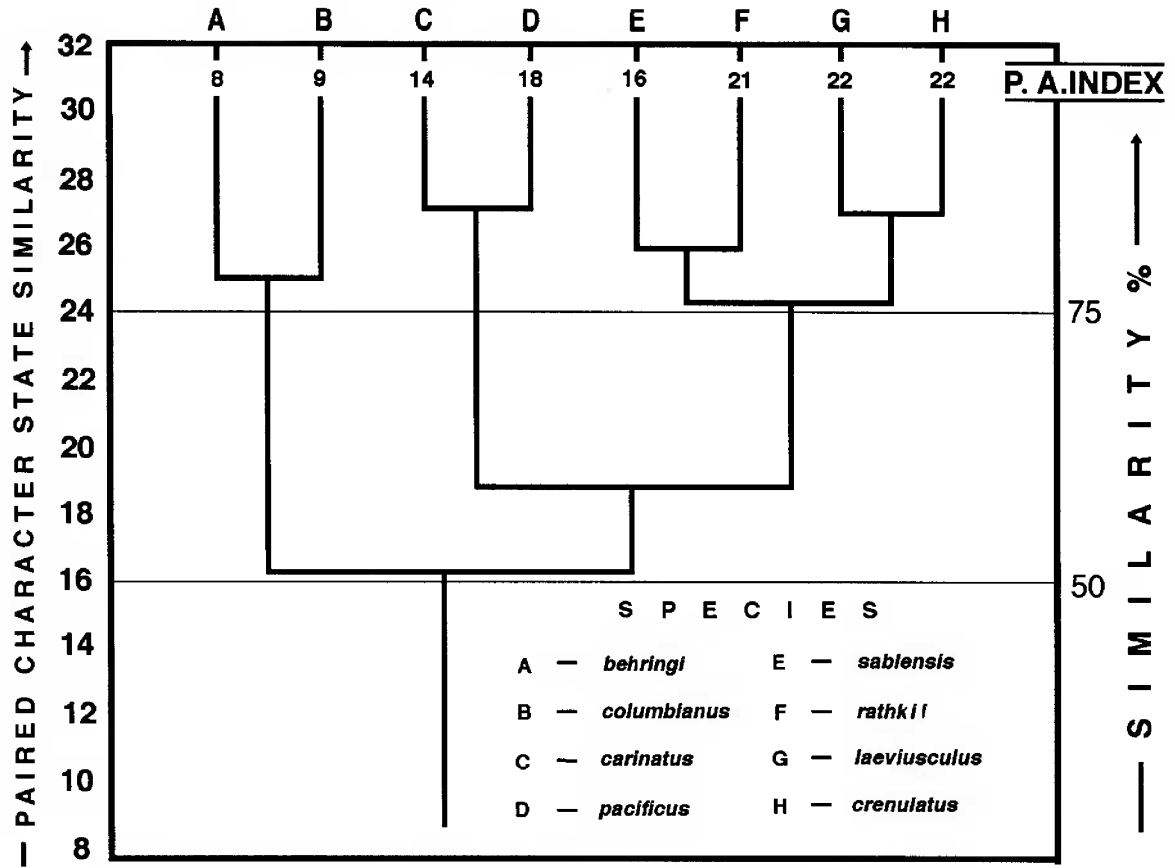


FIG. 40. PHENOGRAM: HOLARCTIC SPECIES OF *CALLIOPIUS*

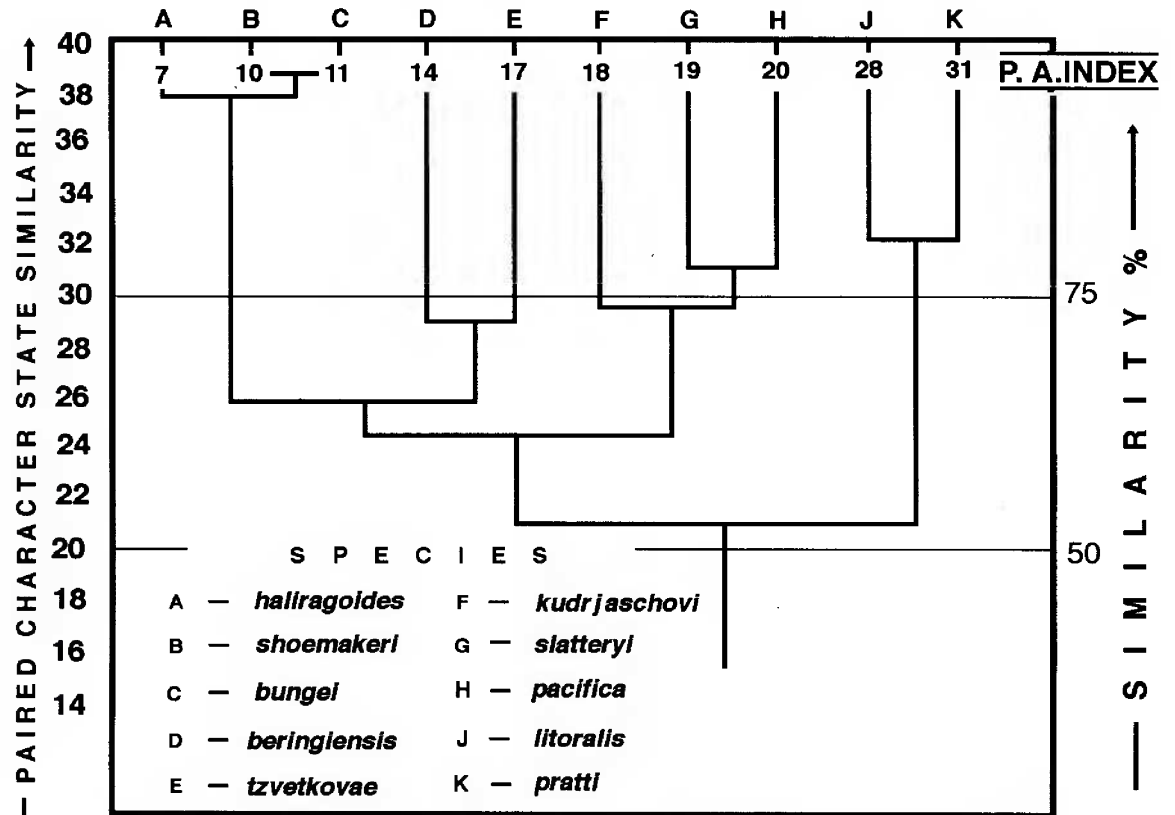


FIG. 41. PHENOGRAM: NORTH PACIFIC SPECIES OF *PARACALLIOPIELLA*

smooth dorsum, short antennal flagella, short rami of uropod 3, short telson, and strong peraeopod dactyls. In addition, the gnathopod carpus (female) is short, and gnathopod 1 (male) is more strongly subchelate than gnathopod 2.

Species within subgroups of *Paracalliopiella* exhibit disconcerting morphological anomalies. Thus, within subgroup (2), *P. beringiensis* has a short mandibular palp segment 3, and squarish hind corner of pleon plate 3, character states that are reversed in *P. tzvetkovae*. Within subgroup (3) (above), *P. pacifica* has an elongate mandibular palp, strongly setose posterior margin of gnathopod propods, and elongate telson, but the reverse is true in *P. slatteryi*. Within subgroup (4), *P. litoralis* has an elongate mandibular palp segment 3, and maxilla 2 inner plate is strongly marginally setose, character states that are reversed in its North American counterpart, *P. pratti*. However, until more thorough examination of type material can be undertaken, these cross-subgroup inconsistencies are here considered indicators of convergent evolution rather than phyletic significance.

Family Calliopiidae: a broader concept?

The present study may shed some light on broader aspects of calliopiid classification and phylogeny. The taxonomic basis for submergence of Pontogeneiidae Stebbing, 1906, and possibly Bateidae Stebbing, 1906, within Calliopiidae Sars, 1895, remains moot. As noted above (p. 5), Barnard & Karaman (1991) have united calliopiids and pontogeneiids within a much broadened concept of family Eusiridae. However, they retained Bateidae as a separate family based solely on the degenerate condition of gnathopod 1. Some character states, especially of mouthparts, in some "classically" pontogeneid genera such as *Accedomoera* J. L. Barnard, 1969b, and bateid genera such as *Carinobatea* Shoemaker, 1926, overlap considerably. These genera might readily be classified as calliopiid, perhaps closest to *Paracalliopiella* and *Oligochinus*, except for the more deeply separated telson lobes (see also Ortiz, 1991). Thus, *Accedomoera* has a notched inferior antennal sinus, short antennal peduncles, minute accessory flagellum, and strong bundles of aesthetascs on alternating segments of the flagellum of antenna 1. In addition, its mouthparts are similar, peraeopods 5-7 are similarly homopodous, and the rami of uropods 1 & 2 are linear and unequal. In *Accedomoera*, too, the antenna, are strongly calceolate, segment 3 of the mandibular palp is strongly subfalciform, the lower lip shows incipient inner lobes, and the lanceolate, marginally plumose-setose rami of uropod 3 are reminiscent of the condition in the calliopiid type genus *Calliopus*. However, until full examination of representative species of all pertinent genera can be undertaken, sufficient real taxonomic differences remain, singly or in combination, especially of the gnathopods, coxal gills, and telson, that continued recognition of the Calliopiidae as a distinct family within superfamily Eusiroidea remains justifiable.

Relationships of Calliopiidae and Gammarellidae

Largely on the basis of micromorphology of the antennal calceolus, J. L. Barnard (1989) resurrected family Gammarellidae, which had been submerged within family Calliopiidae by Bousfield (1983). Barnard expanded its generic composition to embrace the arctic-subarctic genus *Gammarellus* Herbst and the antarctic genera *Gondogeneia*, *Austroregia* and *Chosroes*. His lead has been followed by recent authors including DeBroyer & Jazdzewski (1993) and Palerud & Vader (1991). Encompassed taxa share the following (mostly plesiomorphic) character states: medium to large body size, strongly dorsally carinate bodies (especially pleon), basic mouthparts, homopodous peraeopods, fully developed uropods with lanceolate rami, and plate-like telson with median setae and emarginate apex. Antennal calceoli are usually present, and of a complex form having stalk and bulla, large receptacle, and distal elements separated into 3 (or more) units. *Gammarellus* is especially primitive in having a well-developed accessory flagellum (vestigial in all others), pleated coxal gills, present on peraeopod 7, and multicalceolate antennae. Other character states typical of the Gammarellidae are: uropod 3, rami elongate, marginally setose, outer ramus the longer; maxilliped, palp segment 2 distally broadest; aesthetascs in bundles on alternate segments of antennal flagellar segments; anterior head notch deep, broad; mandibular palp segment 3 falciform; gnathopods strongly subchelate but little sexually dimorphic; gnathopod carpus shorter than propod; maxilla 1 with 9-11 apical spines (9 in *Austroregia regias* which may prove to be a pleustid!)

The *bungei* subgroup within the North Pacific genus *Paracalliopiella* variously bears a strong superficial resemblance to these genera. Similarities are especially close to *Gammarellus* on the one hand, and *Austroregia* on the other. However, calceoli are lacking in all species of *Paracalliopiella*, so a critical "Barnardian" comparison at family level cannot be made at present. However, it is unlikely that the similarities of the *bungei* subgroup (above) can be entirely convergent. This subgroup links the calliopiids and the gammarellids rather closely. Perhaps a further species of the *bungei* group bearing antennal calceoli will yet be discovered, and thereby facilitate full taxonomic evaluation of these genera at family level.

One final point of "spinoff" from this study might be raised. Steele (1995) has queried the concept of a pelagic, ancestral amphipod type, as developed by the senior author [e.g. in Bousfield and Shih (1994)]. Evidence amassed by Steele, mainly from eusiroidean examples, points to an essentially benthic ancestral type with pre-amplexing reproductive behaviour, from which various lines of pelagic and/or otherwise free-swimming morphotypes arose. While evidence from the present study on calliopiid amphipods is not critical, the characters and character states analyzed here suggest that evolutionary trend within component North Pacific genera is from a free-swimming body form, with

TABLE II. DISTRIBUTION OF SPECIES OF CALLIOPIIDAE: NORTH PACIFIC REGION

S P E C I E S	B I O G E O G R A P H I C Z O N E S								
	1	2	3	4	5	6	7	8	9
1. Weyprechtia									
<i>heugleni</i> (Buchholz)		x	X						
<i>pinguis</i> (Kroyer)			X						
2. Apherusa									
<i>megalops</i> (Buchholz)			?						
<i>glacialis</i> (Hansen)			X			?			
3. Laothoes									
<i>pacificus</i> Gurjanova		X	X						
<i>polylovi</i> Gurjanova		X	X						
4. Halirages									
<i>fulvocincta</i> (M. Sars)		x	X						
<i>nilssoni</i> Ohlin		x	X						
5. Bouvierella									
<i>carcinophila</i> Chevreux		?		?	X				
6. Oradarea									
<i>longimana</i> (Boeck)		?			X	X	X		
7. Calliopijs									
<i>laeviusculus</i> (Kroyer)		?	?		?				
<i>behringi</i> Gurjanova		X	X	?					
<i>columbianus</i> , n. sp.			x	X	X	X			
<i>carinatus</i> , n. sp.				X	X	X	X		
<i>pacificus</i> , n. sp.				X	X	X	X		
8. Paracalliopiella									
<i>litoralis</i> (Gurjanova)		X	X						
<i>bungeoi</i> (Gurjanova)		X	X						
<i>pacifica</i> Tzvetk. & Kudr.		X	X						
<i>tzvetkovae</i> , n. sp.		X	X						
<i>shoemakeri</i> , n. sp.			X						
<i>beringiensis</i> , n. sp.			X						
<i>slatteryi</i> , n. sp.			X						
<i>haliragoides</i> , n. sp.			?	X					
<i>kudrjaschovi</i> , n. sp.			X	X					
<i>pratti</i> (J. L. Barnard)			X	X	X	X	X		
9. Oligochinus									
<i>lighti</i> J. L. Barnard			x	X	X	X	X	X	

Legend: 1. SE Japan Sea; 2 NW Sea of Japan & Sea of Okhotsk ; 3. S. Chukchi & Bering Seas; 4. S.E. Alaska; 5. Northern B. C.; 6. Southern B. C.; 7. Wash.-Oregon; 8. Northern and Central California; 9. Southern and Baja California. Occurrence: X - common; x - rare or marginal; ? - questionable occurrence.

calceolate antennae, natatory uropods, and slender, sexually similar gnathopods, to a benthic crawling or nestling body form. During the process of changing life style, antennal calceoli are gradually reduced and eventually lost, uropods transform from lanceolate and setose to linear and spinose, suitable for ambulation or saltation, and gnathopods become increasingly powerfully subchelate, sexually dimorphic, and pre-amplexing in the male. The primary "swimming-perching" nature of amphipod crustaceans, proposed by Steele (1988), and pelagic reproductive searching, remain the probably most correct ancestral behaviour patterns and best fit the morphological evidence within extant members of the Calliopiidae.

Biogeographical discussion.

The distribution of 26 species and 9 genera of family Calliopiidae in the North Pacific region is outlined in Table II. Twenty-one of these species are essentially intertidal and/or littoral in bathymetric range; only three species (*Halirages fulvocincta*, *Laothoes polylovi*, and *Apherusa megalops*) might be considered fully sublittoral, and only two (*Bouvierella carcinophila* and *Oradarea longimana*) are deep sublittoral to bathyal. As noted above (p. 57), the North Pacific assemblage represents about one-third of the known holarctic calliopiid fauna of 70+ species, in 15 genera, most species of which occur along Arctic and North Atlantic coastlines (Palerud & Vader, 1991) south to the Mediterranean (Lincoln, 1979; Krapp-Schickel, 1982) and middle Atlantic states regions (Bousfield, 1973; Watling, 1981). More than 50 calliopiid species, in 16 mostly antiboreal genera, are also known from Antarctic waters (DeBroyer & Jazdzewski, 1993; Barnard & Karaman, 1991) where, in the absence of gammaroideans, they dominate rocky intertidal and littoral marine habitats.

North Pacific calliopiids can be grouped regionally into: (1) an essentially Beringian fauna (in biogeographical zone 3) of 19 species, in 8 genera, of which 6 species have not been recorded elsewhere; (2) an Asiatic North Pacific assemblage (in zones 1 & 2) of 11 species, in 6 genera, none of which is endemic and occurs also in the Beringian region; and (3) a North American Pacific fauna (in zones 4-9) of 9 species, in 5 genera, of which 5 species are apparently endemic and only four occur also in the Beringian region. The western and eastern North Pacific calliopiid faunas appear to be approximately equal in numbers of species, and extend southward over coastlines of comparable length and latitudinal range (S. Korea, to lat. 36° N., and California, to Pt. Conception, at 34° N., respectively). The southern limit of littoral marine calliopiids in the western North Pacific conforms with the discontinuity belts of distribution of northern and southern faunas in the Sea of Japan outlined by Nishimura (1965). Until the faunas are more extensively known, full explanation of the apparently higher percentage of calliopiid endemics along North American shores may be premature. However, as outlined in earlier regional comparisons (e.g., Bousfield & Hoover, 1995), year-round thermal stability and ice-free winter climate of the eastern North Pacific contrast with the

harsher temperature regime and severe winter icing along northwestern Pacific shores, and in the Bering Sea region. Such edaphic differences, effective over long geological periods, may have mirrored by corresponding differences in niche diversity and stability in the two regions. The North American Pacific boreal coastline may have been less suitable for cold-adapted Beringian species on the one hand, but more amenable to new evolutionary "opportunities" on the other, thus contributing to the observed faunal differences.

We may conclude, therefore, that the North Pacific calliopiid fauna is centred in the Beringian region. It extends southward virtually unchanged along Asiatic Pacific shores to the limit of cool-temperate (boreal) inshore marine climates. Along the North American coastline, however, the Beringian fauna is replaced almost entirely by regionally endemic counterpart species.

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